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THE

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VOL. X.

JANUARY—DECEMBER, 1873.

J C Branner

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OR,

Monthly Journal of Geology:

WITH WHICH IS INCORPORATED

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NOS. CIII. TO CXIV.

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HENRY WOODWARD, F.R.S., F.G.S., F.Z.S.,

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TO OUR GEOLOGICAL FRIENDS AND THE SCIENTIFIC PUBLIC.

The Tenth Volume of the Geological Magazine, forming Decade I. of that Journal, is now completed. The New Year, 1874, witnesses the beginning of a "*New Series*," and the commencement of Decade II.

Looking back to the early days of this work, in 1864, we have to deplore the loss of many dear and distinguished friends and fellow-labourers in this branch of science who have passed from amongst us; but we gratefully recognize a large accession of new and able geologists and palæontologists, who have already rendered valuable aid to the Geological Magazine.

We need and desire for the coming Decade the support of every Geologist in this Country, in the Colonies, and in America; and earnestly beg them to give us their subscriptions and contributions.

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The Editor.

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THE

GEOLOGICAL MAGAZINE.

No. CIII.—JANUARY, 1873.

ORIGINAL ARTICLES.

I.—Notes on Fossil Insect-Remains.

The Geological Magazine is fortunate in having received within its pages many contributions relative to the discovery of Fossil Insect-remains, both in this country and abroad.

The first of these appeared in Vol. III., 1866, at p. 97, from the pen of that distinguished geologist and palæontologist, Professor Phillips, M.A., LL.D., F.R.S., and describes the wing of a new Dragon-fly under the name of *Libellula Westwoodii*, from the Stonesfield slate near Oxford, a locality rendered historical by the writings of Buckland, and still more so by the recently published work of his eminent successor in the Chair of Geology at Oxford.[1]

Mr. J. W. Kirkby (Geol. Mag., 1867, Vol. IV., Pl. XVII., Figs. 7 and 8, p. 388) adds a notice of the remains of two Orthopterous insects from the Coal-measures near Sunderland; and in the same volume (at p. 385) Principal Dawson, of Montreal, records the remains of five new insects from the Devonian shales, St. John's, New Brunswick (see Pl. XVII., Figs. 1–5).

In 1868, Vol. V., pp. 172 and 216, Mr. Samuel H. Scudder, Curator of the Museum of the Boston Society of Natural History, Boston, U.S., gave a full account of eighty-seven species of insects, six of which are from the Devonian, fifteen from the Carboniferous, one from the Trias, and sixty-five from the Tertiaries. Ten of these are *Coleoptera*, four *Orthoptera*, nine are *Neuroptera*, five either *Orthoptera* or *Neuroptera*, three are *Hymenoptera*, forty-five are *Diptera*, six *Hemiptera*, while three are *Lepidoptera*, one doubtful Carboniferous form, and two from the Tertiaries; and two are *Myriapoda* from the Carboniferous.

In a paper which appeared in September, 1871 (see Geol. Mag., Vol. VIII., Pl. XI., p. 385), a form of Arachnide, under

---

[1] "Geology of Oxford and the Valley of the Thames," by John Phillips, M.A., F.R.S., F.G.S., Professor of Geology in the University of Oxford. Royal 8vo. pp. 524. Oxford, 1871. Clarendon Press. In this work are also figured *Buprestidium : Curculionidium : Hemerobioides giganteus*, and *Libellula Westwoodii : Blapsidium Egertoni*, *Melolonthidium* and *Prionideum* are recorded as occurring at Eyeford and Stonesfield (p. 174). Brodie's Fossil Insects (published in 1845) contains notices of 9 *Coleoptera*, 3 *Orthoptera*, 3 *Hemiptera*, etc., 8 *Neuroptera*, and 1 *Diptera* from the English Lias. The Purbeck also has yielded numerous Insect-remains, viz.: 8 *Coleoptera*, 7 *Neuroptera*, 3 *Orthoptera*, 10 *Homoptera*, 12 *Diptera*; numerous other Insect-remains have been obtained from the Gt. Oolite, Sevenhampton (see Brodie's Fossil Insects), and other localities.

the generic title of *Eophrynus*, was redescribed by H.
from a new and very perfect specimen; it having bee
figured and described by Dr. Buckland as *Curculioides P*

This paper is accompanied by a list of 44 insects fro
measures, 7 from the Devonian, and 1 Permian example.

Another new British Arachnide, named *Architarbus*
H. Woodw., from the Coal-measures, Lancashire, and
species from the Coal of Illinois, U.S., named *Architarbus*
Scudder, were figured and described in GEOL. MAG., 1872
Pl. IX., p. 385.

Lastly, in the GEOLOGICAL MAGAZINE for December we fi
reprinted the description of a new fossil Butterfly, *Satyrite*
from Aix in Provence, determined by Mr. Samuel H. S
Boston, U.S.

It is no small pleasure this month to add the description
Lepidopterous insect from the Stonesfield slate near Oxfor
together with figures and descriptions of two other fo
Aix-la-Chapelle and Radaboj in Croatia, have been kindly
cated to us by the author of "Lepidoptera Exotica,"
current January number of that work. EDIT. GEO

II.—ON A FOSSIL BUTTERFLY BELONGING TO THE *NYMPHALIDÆ*, FROM THE STONESFIELD SLATE NEAR WITH NOTICES OF TWO OTHER FOREIGN FORMS FROM AND CROATIA.

By ARTHUR G. BUTLER, F.Z.S.,
of the British Museum.

(PLATE I.)

GENUS *Palæontina*, Butler (fossil). Frontwing ovate tri
costal nervure much swollen at base; subcostal four-b
the first two branches emitted about half-way between
cell and apex; the third emitted abnormally just beyond
and therefore springing from beneath the nervure; the
emitted in a still more unusual manner from the third; so
third and fourth branches might be described as springing
from a footstalk emitted from beneath the subcostal; disco
and discoidal nervures precisely as in *Caligo;* median b
nearer together than in *Caligo;* submedian nervure followi
same direction as the median nervures, but even more di
inarched, so that the internal area is considerably widened
wing and body wanting. Type *Palæontina oolitica.*

Palæontina oolitica, sp. n. Pl. I. Figs. 1, 2. ♂ ?

Alæ anticæ costa bene producta apud apicem arcuata; margine externo
paululum arcuato; margine interno brevissimo arcuato; venis ferrugineis;
obsoletis: exp. alar. circ. unc. 5, lin. 3.

---

[1] This description and the accompanying Plate are, by the kind permissio
author, extracted from and issued simultaneously with Part XV. of the "Lep
Exotica," or "Descriptions and Illustrations of Exotic Lepidoptera," for J
1873. By A. G. Butler, F.Z.S. (p. 126, pl. xlviii.)

rdshire). Coll. Edward Charlesworth.

l insect, this species belongs to a group
arest allies are the genera *Caligo*, *Dasy-*
all three essentially tropical American

y interesting, as being *the oldest fossil*
the most ancient previously known to
in the Cretaceous series (white sandstone
the bulk of the known species are from
Croatia: it is also interesting as belong-
f butterflies, and to a sub-family inter-
en two others, namely the *Satyrinæ* and
re recently discovered fossils are refer-
the two latter groups. The nervures
regnated with iron, which will partly
ed condition. I have thought it well to
tions of two fossils from the Cretaceous
y to show the remarkable state of preser-
and colour, which they exhibit when
ic, but in order that I may render more
respecting them in my Catalogues of
epidoptera.
(*Satyrinæ*). *Neorinopis sepulta*, Plate I.,

. Ent. Soc. France, p. 371, pl. 8 (1840). *Vanessa*
France, p. 71, pl. 3, figs. A—C (1851).

Sandstone of Aix-la-Chapelle.
sition of this species in my Catalogue of
showing that its nearest ally is *Neorina*
species, but that it also has a slightly
to *Antirrhæa Philoctetes* and *Anchiphlebia*
pical American forms; the amount of
o first of these species, may be seen on
4 and 5; the resemblance to *Anchiphlebia*
inity more doubtful. It has nothing to do

(*Nymphalinæ*). *Junonia? Pluto*, Plate I.,

Mem. Soc. Helv. xi., p. 181, pl. 14 (1850).

ne of Radaboj, Croatia.
es at p. 109 of my Catalogue of Fabrician
W. H. Edwards of W. Virginia having
f N. America that it is unquestionably an
ana, notwithstanding the important dis-
ints out. That it may bear some distant
quite possible, but that it is "plainly an
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ia near to *J. Hedonia* (see Fig. 6); and I

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species
Lyell's Elements of Geology, p. 243, sixth ed., 1865.

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This paper
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Another ne
H. Woodw.,
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Scudder, were
Pl. IX., p. 38
Lastly, in th
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from Aix in
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It is no smal
Lepidopterous
together with
Aix-la-Chapell
cated to us
current Januar

II.—On a
Nymphali
with Not
and Croa

Genus *Pale*
costal ne
the first two
cell and apex
and therefore
emitted in a sti
third and fourt
from a footstal
and discoidal
nearer together
same direction
inarched, so tha
wing and body
Palæontina oc
Alæ anticæ costa
paululum arcuato;
obsoletis: exp. alar.

---

[1] This descripti
author, extracted
Exotica," or "
1873. By A [illegible] p. 126, pl. xlviii.) [illegible] ry,

Stonesfield Slate (Oxfordshire). Coll. Edward Charlesworth, Esq., F.G.S.

Though a British Fossil insect, this species belongs to a group completely tropical; its nearest allies are the genera *Caligo*, *Dasyophthalma*, and *Brassolis*, all three essentially tropical American genera.

P. oolitica is especially interesting, as being ***the oldest fossil butterfly yet discovered;*** the most ancient previously known to science having been found in the Cretaceous series (white sandstone of Aix-la-Chapelle), whilst the bulk of the known species are from the Lower Miocene beds of Croatia: it is also interesting as belonging to the highest family of butterflies, and to a sub-family intermediate in character between two others, namely the *Satyrinæ* and *Nymphalinæ*, whilst the more recently discovered fossils are referable, with one exception, to the two latter groups. The nervures appear to have been impregnated with iron, which will partly account for their well-defined condition. I have thought it well to add to my plate representations of two fossils from the Cretaceous and Miocene series, not only to show the remarkable state of preservation, as regards pattern and colour, which they exhibit when compared with the Jurassic, but in order that I may render more definite certain remarks respecting them in my Catalogues of Fabrician and Satyridian Lepidoptera.

Genus *Neorinopis*, Butler (*Satyrinæ*). *Neorinopis sepulta*, Plate I., Fig. 3.

Cyllo sepulta, Boisduval, Ann. Ent. Soc. France, p. 371, pl. 8 (1840). *Vanessa sepulta*, Lefebvre, Ann. Ent. Soc. France, p. 71, pl. 3, figs. A—C (1851).

Upper Cretaceous White Sandstone of Aix-la-Chapelle.

I have discussed the position of this species in my Catalogue of Satyridæ (pp. 189, 190); showing that its nearest ally is *Neorina Lowii*, a common Bornean species, but that it also has a slightly more distant relationship to *Antirrhæa Philoctetes* and *Anchiphlebia archæa*, two common tropical American forms; the amount of affinity, as regards the two first of these species, may be seen on referring to Plate I., Figs. 4 and 5; the resemblance to *Anchiphlebia* is less striking, and the affinity more doubtful. It has nothing to do with *Cyllo*.

Genus *Junonia*, Hubner (*Nymphalinæ*). *Junonia ? Pluto*, Plate I., Fig. 7.

Vanessa Pluto,[1] Heer, Nouv. Mem. Soc. Helv. xi., p. 181, pl. 14 (1850).

Lower Miocene Marlstone of Radaboj, Croatia.

I have noticed this species at p. 109 of my Catalogue of Fabrician Diurnal Lepidoptera, Mr. W. H. Edwards of W. Virginia having decided in his Butterflies of N. America that it is unquestionably an *Argynnis* allied to *A. Diana*, notwithstanding the important discrepancies which Heer points out. That it may bear some distant relationship to *A. Diana* is quite possible, but that it is "plainly an *Argynnis*" is quite another thing; to my mind it is plainly a *Vanessid*, probably a *Junonia* near to *J. Hedonia* (see Fig. 6); and I think some points in Heer's description (of which Mr. Edwards takes no notice) are very important, as evidencing its near relationship to *J. Hedonia* rather than to *A. Diana.* He says:—"Along the margin we observe a row of six circular light spots, one of which always lies between two nerves (*Längsadern*), and fills the whole space between these nerves. This light spot does not reach up to the wing-margin, which is again of darker greyish-brown colour; situated in the centre of each patch is a black circular dot. Whether this had once a white eye-spot or not cannot be ascertained with certainty; but it is very probable, as in two at least of these black dots a small, light brown spot is observable in the centre of each. These light eye-spots seem not to be encircled by a black ring."

---

[1] This species is also figured in Lyell's Elements of Geology, p. 243, sixth ed., 1865.

The ocelli are well shown in Heer's figure, but in the woodcuts by Lyell and Edwards, which have in other respects been made much darker than the original, the indication of the lower edge of the ocelli has been omitted altogether, and, consequently, the resemblance to the species of *Junonia* is rendered less evident. I think it just possible, from the great resemblance which *V. attavina* of Heer bears to the undersurface of *J. Hedonia,* that it is the reverse of *J. Pluto.*

In concluding my observations on these three butterflies, I would express my thanks to Mr. Charlesworth for the use which he has permitted me to make of his highly interesting fossil, and for the opportunity which he has thus given me of illustrating my previous remarks on the two species described by Boisduval and Heer.

III.—The Ancient Stone Implements of Great Britain.[1]

(PLATES II. and III.)

FIFTEEN years ago scarcely any attention had been paid to the subject of the earliest evidences of human antiquity in Western Europe.

Many explorers had, it is true, commenced their solitary researches long before in widely different localities, but scientific men had as yet failed to perceive their importance.

Gradually the researches of the geologist and the palæontologist have led to the conclusion that there exists a direct connexion, by descent, between the fauna and flora of our earth, as we see them to-day, and those which peopled and clothed it in Tertiary times, and, as regards the physical conditions of our planet, that it had been influenced by causes similar in character, though varying in their intensity, to those which at present operate upon its surface.

But by long-accepted tradition, Man has been considered as belonging to an entirely separate order of things, having no connexion either with the life of the remote past or with the series of existences around him.

---

[1] The Ancient Stone Implements, Weapons, and Ornaments of Great Britain. By John Evans, F.R.S., F.S.A., Sec. Geol. Soc., etc, etc. Royal 8vo., pp. 640 (profusely illustrated with woodcuts and plates). London: Longmans, Green, and Co., 1872.

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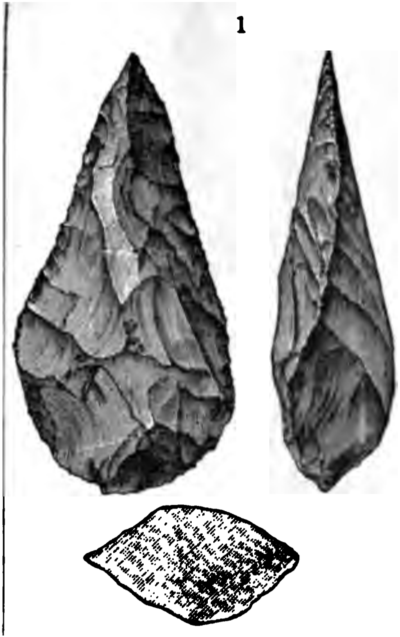

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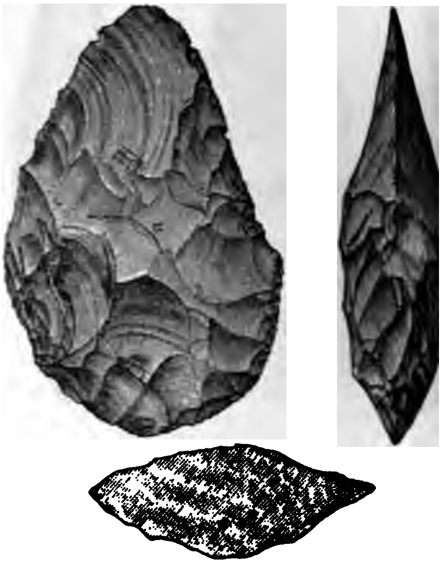

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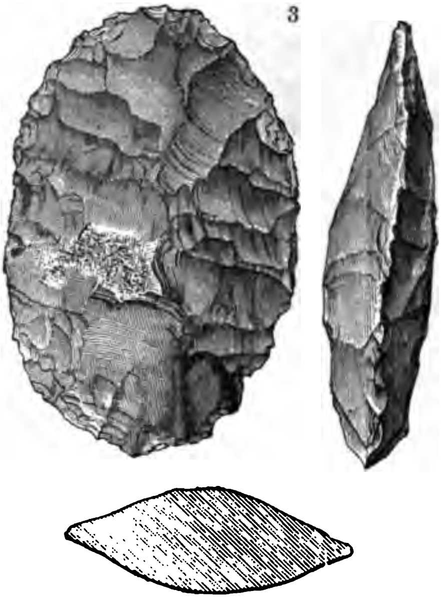

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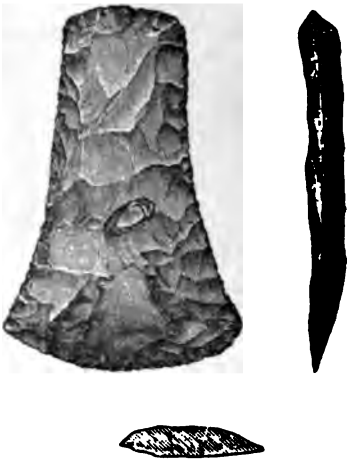

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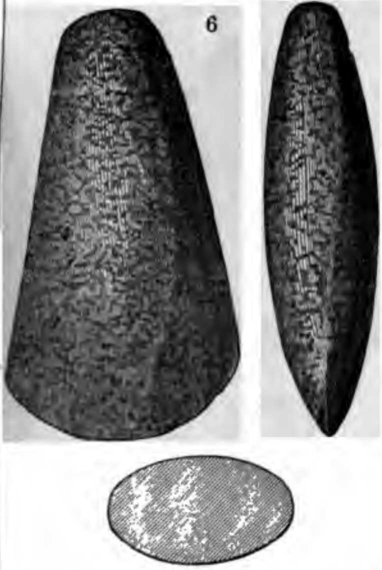

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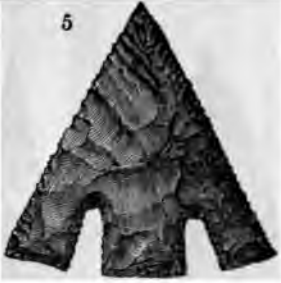

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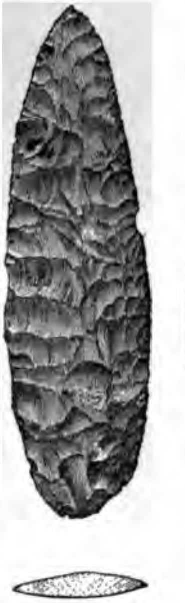

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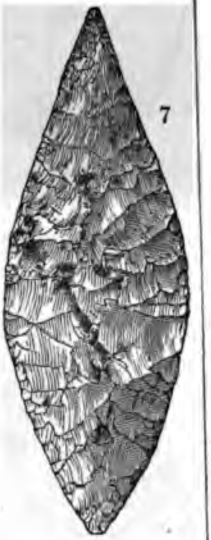

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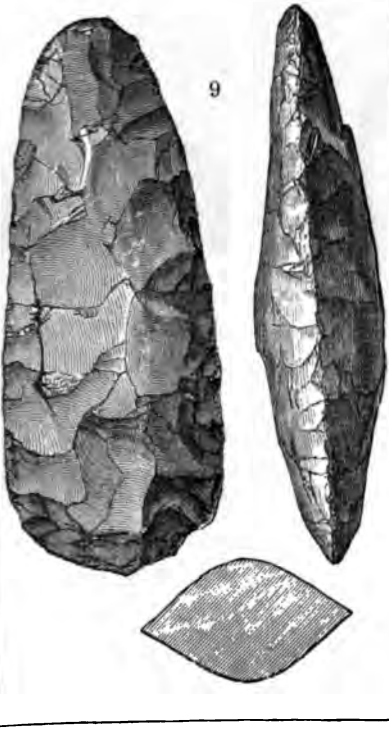

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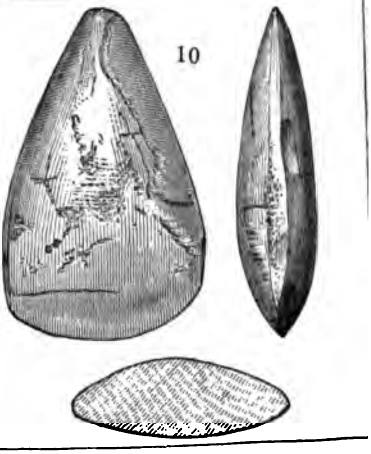

Ancient Stone Implements of Great Britain.

By JOHN EVANS, F.R.S., F.G.S., etc., etc.

In order therefore to complete this continuity of life on the earth it seemed necessary to obtain some further evidences of man's early existence, in addition to that which history or tradition supplied. This evidence was forthcoming. The deposits furnishing it belong to the latest period of our planet's history preceding the present and have been classed by geologists as Quaternary; but they show more clearly perhaps than any other their continuity with our own epoch, interrupted only by the effects of those cosmical and meteoric agencies which are ever slowly changing the surface of our earth in vast cycles of time.

These earliest known evidences of man only reveal to us the primeval savage in his rudest and most uncivilized state; but our ideas of primitive man, as derived from history or tradition, represent him as a highly civilized being endowed with superior intelligence and high moral attributes.

Such qualifications however would have been of little avail, even under the most favoured conditions of climate, as compared with those possessed by the simplest aborigines; nor could they have been transmitted to his descendants: for, however intelligent his mind may have been, he had no experience in the manufacture of, nor was he provided with, the simplest inventions of civilized life.

It would indeed be an anomaly to find a people possessing high social, moral and intellectual qualities without having made the least progress in the useful arts, the civilizing influences of which tend to raise mankind above the level of the savage.

Whatever view, then, may be adopted in regard to the first man, we must all agree that his immediate descendants were unacquainted with metals—a knowledge of which was only acquired after many generations; and consequently that their weapons would be made of the simplest forms, and from the most easily fabricated materials, but often well suited to the purposes for which they were required.

These comprised weapons of the chase, for fishing, for canoe-making, for the formation of rude habitations and garments, and, lastly, those used in primitive agriculture.

We can readily divine the materials out of which these would be formed, by recalling the achievements of our schoolboy days; and, truly, in this sense

> "The child's the father of the man"—

Stones, wood, shells, horns and bones of animals,—such were the simple materials made use of by early man.

But the more fragile articles, in wood, shell, horn and bone, could only be preserved in a few rare situations, which offered sufficient protection to such perishable relics from the destructive effects of the atmospheric agents ever busy on or near the surface of the ground. Thus, in a few isolated districts, caverns have been explored, beneath whose stalagmitic floors have been discovered remains which have made us acquainted with much of the rude arts of these prehistoric people; and not a few early graves have been ransacked for a similar purpose; whilst, strange to say, beneath the waters of almost every lake in Switzerland, and many freshwater lakes, now filled with bog, in Ireland and other countries, remains of pfhalbauten and crannoges afford the only history of their ancient and once numerous inhabitants.

But the objects made of stone, being at once the most ancient and most indestructible, are consequently the most widespread and frequently found of all prehistoric remains.

In river-valley-gravels along the sea-coast, on the downs and moors, over fields and pastures, beside inland lakes and sea-lochs, these relics are found as if they had been sown broadcast over the land by some fairy hand; and, indeed, this idea concerning their origin is well expressed by the names they bear of "elf-dart," "thunderbolt," etc.

It is to the task of describing and classifying these curious stone relics that Mr. John Evans has devoted the past twenty years, and now comes forward with the grand work on the Ancient Stone Implements, Weapons and Ornaments of Great Britain, which we have taken as the subject for our article.

We may perhaps be thought by some to attach too great an importance to these researches; but when it is borne in mind that even now attempts are frequently being made by superstitious and prejudiced persons to throw doubt and discredit on such investigations, and even to endeavour to prove that the very evidence upon which they are based is false and illusory, we cannot but express our sincere gratification on finding all the needful facts and arguments brought together for refuting such heretical fanatics.

It seems essential, then, in order clearly to understand the uses and mode of fabrication of the ancient stone-implements found in Britain, to follow the same inductive method of reasoning as that pursued by the geologist, who, in attempting to account for the vast changes which have taken place in the crust of the earth, finds it safest to refer them to ascertained chemical laws and to the existing operations of nature. These relics of antiquity can, in fact, only be interpreted by reference to the uses and methods of manufacture employed by existing savages in what we may judge to be a somewhat similar state of barbarism.

The accounts of Torquemada, Hernandez and Clavigero, explain the manufacture of obsidian flakes by the Mexican Indians, which, with the knowledge we possess of the manufacture of gunflints at the present day, enables us perfectly to realize the mode in which our prehistoric ancestors in Britain fabricated their precisely similar implements in the Stone Age.

The records of Belcher, Catlin, Schoolcraft, Baines, and numerous other travellers among the North American Indians, the Esquimaux, the native Australian, New Zealander, New Caledonian, and South Sea Islanders, furnish abundant descriptions of the manufacture of arrow-heads, and the mode of making, hafting, and using the various forms of stone-implements corresponding with many found in this country.

"The name of Celt (says Mr. Evans), which has long been given to hatchets, adzes, or chisels of stone, is so well known, and has been so universally employed, that, though its use has at times led to considerable misapprehension, I have thought it best to retain it. It has been fancied by some that the name bore reference to the Celtic people, by whom the implements were supposed to have been made; and among those who have thought fit to adopt the modern fashion of calling the Celts 'Kelts,' there have been not a few who have given the instruments the novel name of 'kelts' also. . . . . . Notwithstanding this misapprehension, there can be no doubt as to the derivation of the word, it being no other than the English form of the Latin *celtis* or *celtes*, a chisel." (p. 50.)

"So far as general character is concerned, stone celts or hatchets may be divided into three classes, which I propose to treat separately as follows:

"1. Those merely chipped out in a more or less careful manner, and not ground or polished;

"2. Those which, after being fashioned by chipping, have been ground or polished at the edge only; and

"3. Those which are more or less ground or polished, not only at the edge, but over the whole surface." (p. 59.)

We have spoken chiefly of celts; but among the 500 illustrations of implements given in Mr. Evans's work, there are figures of various other ancient objects in stone, such as personal ornaments, amulets, etc.; spindle-whorls, discs, slickstones, weights and cups; sling-stones and balls; grinding-stones and whetstones; flaking-tools; stone-hammers; borers, awls, or drills; flint-cores, etc.

The implements themselves comprise rough-hewn celts; celts ground at the edge only; polished celts; picks, chisels, and gouges, perforated axes, perforated and grooved hammers, flint flakes, scrapers, trimmed flakes, knives, etc.; javelins and arrow-heads; and those ruder forms of implements classed as belonging to the "River-drift Period."

At the conclusion of the chapter on the Manufacture of Stone Implements, which is perhaps the most agreeable and interesting in this most instructive book, the author observes, "Here as elsewhere, we find traces of improvement and progress both in adapting forms to the ends they had to subserve, and in the manner of treating the stubborn materials of which these implements were made. Such progress may not have been, and probably was not, uniform, even in any one country; and indeed there are breaks in the chronology of stone implements which it is hard to fill up; but any one comparing, for instance, the exquisitely-made axe-hammers and delicately-chipped flint arrow-heads of the Bronze Age, with the rude implements of the Palæolithic Period,—neatly chipped as some of these latter are,—cannot but perceive the advances that had been made in skill, and in adaptation of means to ends. If, for the sake of illustration, we divide the lapse of time embraced between these two extremes into four Periods, it appears—

"1. That in the Palæolithic River-Gravel, or Drift-Period, implements were fashioned *by chipping* only, and not ground or polished. The material used in Europe was, moreover, so far as at present known, almost exclusively flint.

"2. That in the Reindeer or Cavern Period of Central France, though grinding was not practised, except for some instruments, yet greater skill in flaking flint and in working up flakes into serviceable tools was exhibited. In some places, as at Laugerie-haute, surface-chipping is found on the flint arrow-heads. Cup-shaped recesses have been worked in other hard stones than flint, though no other stones have been used for cutting purposes.

"3. That in the Neolithic or Surface-Stone Period of Western Europe other materials besides flint were largely used for the manufacture of hatchets; grinding at the edge and on the surface was generally practised; and the art of working flint by pressure from the edge was probably known. The stone axes, at least in Britain, were rarely perforated.

"4. That in the Bronze Period such stone implements, with the exception of mere flakes and scrapers, as remained in use, were, as a rule, highly finished, many of the axes being perforated and of graceful form, and some of the flint arrow-heads evincing the highest degree of manual skill." (p. 13.)

By the kindness of the author, we are enabled to reproduce here types of ten different forms of stone implements exhibiting various degrees of progress, from the River Drift Period, represented by Figs. 1, 2, and 3, from Hoxne and Icklingham; to the polished celts of the Neolithic period (Figs. 6 and 10), of hornblende and hornstone, from Suffolk and Northumberland, and the highly finished broad arrow-head, javelin-head, and flint knife or lance-head (Figs. 5, 7, 8), of the Bronze Period, from Yorkshire, Wiltshire, and Essex.

It is interesting to observe, in the long series[1] of specimens figured by Mr. Evans, the adherence to a certain very limited number of patterns,[2] partly, we think, arising from suitability of form, but more from that determined disinclination to change, which all aborigines display. "What our father and grandfather did, that do we."—and it is in vain to attempt to argue the point, or to try to prove any other plan superior. The materials, it is true, in the lapse of ages, changed from rough flint to polished greenstone, or to bronze, but even then, the later stone celts were used as the models on which to mould the earlier bronze axes. (See Pl. II. Fig. 4.)

Fergusson has pointed out the same thing in early Indian architecture, where the passage from wood to stone buildings is marked by the servile imitation of the wooden beams of door-post and lintel without any attempt at higher art. The same gradual and progressive development is observable in early Greek architecture (see the tomb of a Satrap of Lycia, named Paiafa, resembling a wooden coffer or roofed house, with beams projecting from the sides, carved in stone; preserved in the British Museum).

The whole history of the human race is one slow but continued progress. From the condition of the simple Tasmanian or Andaman

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[1] Nearly five hundred.

[2] And these patterns were *cosmopolitan*.

Islander, wandering along the shore, seeking, according to the varying season, the oyster-banks, or the feeding ground of the great *Fusus*, and other Gasteropods, leaving sharp-edged stones by hundreds commingled with the bivalve shells of the oyster and round hammer-stones with the refuse-heaps of the crushed univalves; to that of the more advanced Esquimaux fashioning implements from meteoric iron, quartz crystals, flint flakes, walrus tusks, fossil ivory, reindeer horns, and every other available substance which comes within his reach,—upwards, through all the shades of more or less savage life to that of civilized countries like our own.

"Not the least misunderstood of these subjects is the classification of the antiquities of Western Europe, first practically adopted by the Danish antiquaries, under periods known as the Iron, Bronze, and Stone Ages; the Iron Age, so far as Denmark is concerned, being supposed to go back to about the Christian era, the Bronze Age to embrace a period of one or two thousand years previous to that date, and the Stone Age all previous time of man's occupation of that part of the world. These different periods have been, and in some cases may be safely subdivided; but into this question I need not now enter, as it does not affect the general sequence. The idea of the succession is this:

"1.—That there was a period in each given part of Western Europe, say, for example, Denmark, when the use of metals for cutting instruments of any kind was unknown, and man had to depend on stone, bone, wood, and other readily accessible natural products, for his implements and weapons of the chase or war.

"2.—That this period was succeeded by one in which the use of copper, or of copper alloyed with tin—bronze—became known, and gradually superseded the use of stone for certain purposes, though it remained in use for others; and

"3.—That a time arrived when bronze, in its turn, gave way to iron or steel, as being a superior metal for all cutting purposes, and which, as such, has remained in use up to the present day.

"Such a classification into different ages in no way implies any exact chronology, far less one that would be applicable to all the countries of Western Europe alike, but is rather to be regarded as significant only of a succession of different stages of civilization; for it is evident that at the time when, for instance, in a country such as Italy, the Iron Age may have commenced, some of the more northern countries of Europe may possibly have been in their Bronze Age, and others again still in their Stone Age.

"Neither does this classification imply that in the Bronze Age of any country stone implements had entirely ceased to be in use, nor even that in the Iron Age both bronze and stone had been completely superseded for all cutting purposes. Like the three principal colours of the rainbow, these three stages of civilization overlap, intermingle, and shade off the one into the other; and yet their succession, so far as Western Europe is concerned, appears to be equally well defined with that of the prismatic colours, though the proportions of the spectrum may vary in different countries." (p.2.)

In attempting to compute the vast periods of time which these progressive ages present to our minds, we speedily become aware of the brevity of our own past history,—"when we remember that the traditions of the mighty and historic city now extending across the valley of the Thames do not carry us back even to the close of that period of many centuries when a bronze-using people occupied this island; when we bear in mind that beyond that period lies another of probably far longer duration, when our barbaric predecessors sometimes polished their stone implements, but were still unacquainted with the use of metallic tools;—when to the Historic, Bronze, and Neolithic Ages, we mentally add that long series of years which must have been required for the old fauna, with the mammoth and rhinoceros, and other to us strange and unaccustomed forms, to be supplanted by a group of animals more closely resembling those of the present day;—and when, remembering all this, we realize the fact that all these vast periods of years have intervened since the completion of the excavations of the valley, and the close of the Palæolithic Period, the mind is almost lost in amazement at the vista of antiquity displayed.

"So fully must this be felt, that it is impossible not to sympathize with those who, from sheer inability to carry their visions so far back into the dim past, and from unconsciousness of the cogency of other and distinct evidence as to the remoteness of the origin of the human race, are unwilling to believe in so vast an antiquity for man as must of necessity be conceded by those who, however feebly they may make their thoughts known to others, have fully and fairly weighed the facts which modern discoveries have unrolled before their eyes." (p. 622.) H. W.

EXPLANATION OF PLATES II. AND III.

Fig. 1. Acutely-pointed flint implement. River-drift Hoxne, Norfolk. Half nat. size. (p. 520, fig. 450.)

" 2. Ovate-pointed implement, from the same locality. Half nat. size. (p. 519, fig. 449.)

" 3. Elliptical River-drift implement from Icklingham. Half nat. size. (p. 490, fig. 421.)

" 4. Rough-hewn flint adze expanding at the end, closely resembling a bronze celt in form. Half nat. size. Thetford Warren, Suffolk. (p. 67, fig. 22.)

" 5. Broad arrow-head stemmed and barbed found in front of the face of an unburned body, in a barrow, at Rudstone, near Bridlington. (p. 343, fig. 318.)

" 6. Polished celt of dark-green hornblende schist, found at Lakenheath, Suffolk. Half nat. size. (p. 114, fig. 69.)

" 7. Javelin-head with beautifully worked surfaces found close to the head of a contracted skeleton, in an oval barrow on Winterbourn, Stoke Down, near Stonehenge. (p. 331, fig. 275.)

" 8. Flint knife (or lance-head), Windmill Hill, Saffron Walden. Half nat. size. (p. 301, fig. 250.)

" 9. Symmetrically chipped but unground celt; Reach Fen, near Cambridge. Half nat. size. (p. 68, fig. 23.)

" 10. Polished celt of hard slaty rock or honestone, from Ilderton, Northumberland. Half nat. size. (p. 105, fig. 60.)

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—The Older Deposits in the Victoria Cave, Settle, Yorkshire.

By R. H. Tiddeman, M.A., F.G.S.

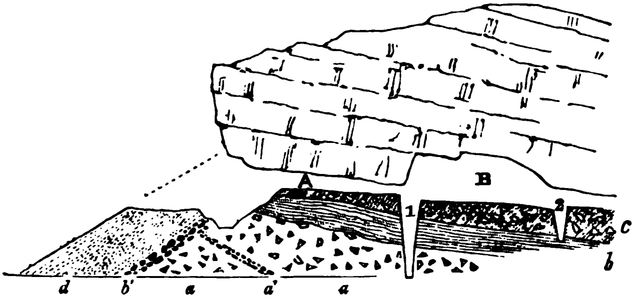
HE following remarks were written for the Settle Caves Exploration Committee in the spring of 1871. They were subsequently mitted to the British Association in 1872, and are, with additions oodying the result of the latest explorations, offered to the scien- public. First, I propose briefly to describe the beds with which have become acquainted in the course of the explorations, their arent range and superposition. Secondly, I will endeavour to w to what natural causes they probably owe their origin.

n doing so I need not give any description of the later deposits m Neolithic times to the present, they having been fully treated by Mr. Dawkins.[1] I will merely remark that they are, so to ak, unconformable to the other deposits, and are mixed up with h of them in succession. In short, they form a floor or floors of upation unconformable to older beds below.

1. The Cave is situated at the base of a vertical cliff of Carbonifer- Limestone at the side of a dry valley, and the ground slopes away eply from the mouth, and is covered with talus. It lies at about 50 feet above sea-level, and consists of three principal chambers.

Victoria Cave, Settle, Yorkshire.

(Scale, 1 inch to 54 feet.)



A, Chamber A; B, Chamber B; 1, 25-foot shaft; 2, 13-foot shaft; *a*, lower cave-earth; *a'*, bone-bed containing the older cave-mammals; *b*, laminated clay; *b'*, glacial drift; *c*, upper cave-earth; *d*, talus, the dotted line showing its upper surface previous to the explorations.

A. the Central Chamber, about 40 yards long; its direction N.N.E.

B. branches off from it on the left, and has a smaller continuation, C., which is not yet explored.

D. lies on the right of A., and is entered from it near the mouth.

The Limestone in which the Cave is excavated is a whitish-grey ssive rock; it dips to the N.N.W. A. is excavated in the bed ich forms the roof of D., and B. in that which forms the roof of

It is probable that all these chambers are really one great ern, but filled with materials up to the inequalities in the roof ich now separates the different chambers. Its floor has never yet n reached.

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[1] Journal of the Anthropological Institute, 1871, and Report of the British Asso- ion for 1872.

(i.)[1] The débris at the entrance consists of a loose angular talus of Limestone, which at the surface has some clay and vegetable mould included in it, but lower down it is very clean. It is without doubt derived from the rocks above by the frosts of successive winters. It is a point worthy of notice, however, that though for the most part made up of loose, small, independent fragments, in many places you may see, on looking more closely, that very large blocks have fallen and become disintegrated by or after their fall, and their component pieces, although separated by chinks, are still lying in their relative positions. This shows that the rate of accumulation at any one spot is very irregular, and that any calculations with regard to absolute, or indeed relative, time, based upon the thickness of the débris, are very far from being infallible, especially where it is thin.

(ii.) The débris graduates below at the entrance almost imperceptibly into a yellowish-brown clay, with angular fragments of Limestone. This extends, so far as we can tell, over the whole Cave, but is thinnest near the entrance. In a shaft sunk to the depth of 25 feet at the junction of Chamber B. with Chamber A. this bed was 6 feet thick; and in a 13 foot shaft at the end of Chamber B. it shows a thickness of 10 feet, and is possibly greater. In the 25 foot shaft it contained a good deal of stalagmite, which was very soft and rotten; three beds, much harder, which had to be blasted, occurred in it in the 13 foot shaft. Very massive blocks of Limestone lie on its surface in several places, but more particularly at the further end of the Central Chamber (A.), where the form of their upper surface corresponds to that of the roof, and shows that they have simply fallen from above. But large and small masses of Limestone occur throughout its whole thickness. The fragments are nearly all angular, and do not show any signs of rolling nor of glacial scratches.

(iii.) Next below this upper Cave-earth wherever penetrated, we come to a thick bed of fine dark-brown and yellow laminated clay. The laminations are very distinct, tolerably regular, and for the most part very thin; and the clay, when pulled asunder, flakes off along the planes of bedding, the alternations consisting of excessively fine sand and tenacious clay. In section it has much the appearance of streaky gutta-percha. With acid it effervesces freely, about 8 per cent. of its weight being dissolved. This laminated clay is at the surface near the entrance of the Cave, but dips steadily, though not regularly, towards the inner part. It was well seen in two shafts sunk in Chamber A., in both of which it dips to the right towards Chamber D., and appears to underlie the whole of that chamber. On the left it dips towards and into Chamber B., and was ascertained by Mr. Jackson, the superintendent, to have there an inclination of 1 in 9, rather more than 6°. It shows a thickness of 12 feet in the 25 foot shaft, the lowest, 12 inches, consisting entirely of a pure yellow clay. The last foot and a half of the 13 foot shaft was in clay, probably the top of this bed; but the water dripping from the roof prevented the shaft being continued, so that it could not be ascertained with certainty. The same angle of dip continued from the 25 foot shaft would just bring the top of this bed to where the pure clay was reached in the 13 foot shaft, so that it is highly probable that it is the same.

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[1] Although the upper portion of this is necessarily recent, it has probably been forming ever since the Glacial Period, and therefore deserves to be classed with "The Older Deposits."

No organic remains whatever have been found in this bed. It is a deposit well adapted for preserving organic structures; and I have frequently searched it in hopes of finding something embedded in it, but hitherto without success. I have also examined it carefully with a microscope, but have not seen a trace of any animal or vegetable organism.

(iv.) The lowest set of beds to which we have as yet attained comes next in order of descent. It is in all respects, save the remains which it contains, similar to ii. Seven feet of it were shown in the bottom of the 25 foot shaft in Chamber B. It consists of large and small blocks of Limestone in a matrix of sandy clay. The stones are neither rounded nor scratched. No remains were found in it in this shaft, but at the entrance of the Cave, at a depth in this bed of about 16 feet from the base of the laminated clay, was a yellow layer, a floor of occupation dipping into the Cave, at an angle of 15° or 20°, full of hyæna coprolites, and containing the following remains, kindly determined by Mr. George Busk, F.R.S., in May and June, 1872:—

Elephas primigenius (milk molars).
Elephas. Small size (fibula).
Ursus spelæus.
Ursus priscus.
Hyæna spelæa.
Rhinoceros tichorhinus.
Bison.
Cervus elaphus.

2. I will now proceed to consider the probable origin of these deposits, and, with a view to that, will just glance at the position of the Victoria Cave. It burrows into the side of a cliff above the 1400 foot level on the east side of a lateral valley which forms a *col* between the comparatively narrow valley of the Ribble above Settle and its broad alluvial plain below that town. The Cave is situated on the watershed of the little valley, or rather what would be its watershed, were it not excavated in permeable limestone.

(i.) The origin of the talus is undoubted: it points simply to agents still in operation here, the disintegration of the cliffs by weather. It must certainly be Post-glacial, for any glacier passing in this direction would certainly remove it; and there are abundant proofs that ice did pass by here.

(ii. and iv.) The similarity of the deposits ii. and iv. is so great that there can be little doubt they were made under similar conditions, and are due to similar causes. (The bed of laminated clay between them is quite different, and must be referred to quite a distinct state of things.) The angularity of the fragments and the absence of any appearance of rolling forbid us to refer them to the sea; with this may be coupled the absence of distinct bedding, save where layers of stalagmite or of bones occur, and the irregularity with which the blocks are dispersed throughout the mass without reference to coarseness and fineness of material. Nor can they be

[illegible]

[illegible] very small semi-angular scratched stones... [illegible]

[illegible] of the laminated clay only a few inche broad no distinction could be drawn between that here and that in the Cave, in larger specimens in the coal-shaft it was seen to have been much crumpled, as if by lateral pressure. It seems highly probable that the laminated clay in the coal-shaft was the result of glacier water in some quiet hollow beneath the edge of the ice-sheet, or its waning representative, and that it was squeezed after deposition by the ice which left the till upon it. In the Victoria Cave the deposit would have been protected from any such subsequent disturbance. In the coal-shaft the scratched boulders show that it was a glacial deposit. They may have been dropped into the mud from the ice above. In the cave the limestone roof would prevent such an occurrence.

Since the British Association grant was made (1872), further excavations have brought to light beneath all the talus at the mouth of the Cave a bed of tenacious clay with scratched Silurian and other boulders *resting on the edges of the beds containing the older mammals*, and dipping outwards at an angle of 40°. Mr. T. M'K. Hughes has suggested that we must bear in mind the possibility of this Boulder-clay not being in its original position, but having fallen from the cliff. It will be seen in the section that all the talus, and that of considerable thickness, lies above it. Nor is the whole of the talus which has fallen from the cliffs, and so represents a rude measure of their disintegration, here shown, a much greater quantity lying lower down the slope. If we were to *remove* all the talus, it would be barely possible *now* for the Boulder-clay to fall vertically from the cliff into its present position. But were we to *restore* to the cliff all the fragments of Limestone which it has lost since the deposition of the Boulder-clay, it would, I think, be quite impossible for such a fall to occur.

Taking all the circumstances together, it seems more likely that the drift here is the remnant of a *moraine* (lateral or *profonde*) which dammed up the mouth of the Cave, and prevented anything but water charged with fine sediment from entering it during the Glacial Period. It is a rather significant fact that all the deposits below this till are charged with mud, whilst those above it, consisting entirely of fallen talus of great thickness, are, except quite at the surface, completely free from it. Also many of the limestone fragments close beneath the drift appear to have lost much of their surface from the solvent power of water and carbonic acid; for they are rounded to some extent, but not rolled. Perhaps one of the strongest pieces of evidence that the older cave mammals mentioned at p. 13 lived in this district only at a time previous to the great ice-sheet is, that so far as we know the remains of none of them (except of *Cervus elaphus*, which ranges from the Forest-bed to the present day) have been found in any of the Post-glacial deposits of this district. Though so common in the river-gravels in the Midland and Southern counties, they are never found except in caves until we get much further south or east. Leeds, I believe, is the nearest locality where they occur. This would seem to imply that their remains were wiped off the area by the great ice-sheet which occupied what is now the

Irish Sea and its tributary river-systems, and only left in the shelter of caves to which it could have no direct access. Brown bear, horse, red deer, reindeer, megaceros, the more modern bovidæ, and other more recent forms are not uncommon in the Post-glacial beds; but the older cave mammals seem conspicuous only by their absence.[1]

V.—On the Occurrence of Copper and Lead Ores in the Bunter Conglomerates of Cannock Chase.[2]

By William Molyneux, F.G.S.

The district known as Cannock Chase is, at the present moment, the scene of a series of extensive mining operations which, if even moderately successful, will open up a very considerable area of valuable coal-seams, computed at not less than 200,000,000 tons, and push outwards a distance of upwards of five miles the nothern apex of the South Staffordshire Coal-field. This apex, as is well known, now rests on Brereton, where the Coal-measures are thrown down on the east by a fault of considerable range and influence, and on the west they are overlapped unconformably by Bunter conglomerates. From this point the conglomerates are continued in a broad unbroken tract over the Chase to within about four miles of the town of Stafford, up to which point the mining investigations, to which I have alluded, will be extended.

A little south of Brereton, in the Old Park at Beaudesert, some of the shallow coals, known as the Old Park coals, and also some bands of ironstone, were worked upwards of 300 years ago, and in all probability, judging, not only from the authenticated condition and value of the works in the time of Edward VI., but also from the size and age of numbers of oak trees which now stand on the old pit banks, both the coals and ironstone were worked even hundreds of years previously. And it is interesting to note, in connexion with these old coal workings, that until the year 1852 they represented a distinct and isolated coal area, no coals having been up to that time worked within a distance of four miles, although, geologically, there is no severance of the coal-seams of the Old Park and those of the other portions of the field situated to the south and west.

The Cannock Mineral Railway from Cannock to Rugeley occupies a valley which runs nearly north and south, and unquestionably marks a line of fault of considerable importance. This fault is laid down in the maps of the Geological Survey, and has long been held as determining the western boundary line of the workable coal seams of South Staffordshire. West of this valley, from a point a little south of the town of Cannock, as far as Brocton and Milford, ranges the old surface area of a large portion of Cannock Chase, the greater part of which is at the present time in a state of nature.

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[1] I am pleased to find in a Settle Caves Exploration "prospectus," just issued with a view to collecting subscriptions, Mr. Boyd Dawkins has adopted my views on these important questions.

[2] Read before the British Association, Brighton, August, 1872.

In the maps of the Survey to which I have alluded, this area, with but a trifling exception, is laid down as Bunter pebble-beds, overspread by unconsolidated conglomerates of the New Red Sandstone, and it was in these beds, at a place called Shore Hill, about a mile north of the town of Cannock, that I first detected, about two years ago, the copper and lead ore to which this paper refers. Before, however, entering upon a description of these ores, I will refer to the extension of Coal-measures beneath the beds of this locality laid down as members of the New Red Sandstone.

Exactly three years ago the West Cannock Colliery Company was formed, and, acting upon my advice, commenced sinking a pair of pits at a point situated a little over half a mile on the west side of the supposed boundary fault, to which I have drawn attention, and the result was that the whole of the valuable coal-seams of the Cannock Chase district, from the horizon of the Brooch coal (which was struck at thirty-five yards), were found within a depth of 300 yards from the surface. The Coal-measures were found to be covered up by six feet of drift sand and clay only, and there is no doubt whatever that this condition, with but little variation, obtains over quite 2000 acres of country lying immediately around. I have the further satisfaction of alluding to these sinkings, as they yielded, in a dark shale lying above the greater proportion of the workable coal, fossils which had never been previously recorded as occurring in South Staffordshire—fossils both generically and specifically identical with forms long held as confined to the horizon of the basement beds of the true coal, and the Lower Carboniferous rocks of this country, namely, *Goniatites*, *Orthoceras*, *Posidonia*, *Aviculopecten*, together with *Lingula* and others, a complete list and description of which I hope to have the opportunity of preparing hereafter. I mention the fact of the occurrence of these shells in beds overlying a thick mass of valuable coals by way of suggesting how careful we should be in forming an opinion as to the mineralogical capabilities of districts merely from the examination of isolated specimens of contemporaneous organic life obtained from it. I may remark that the Bunter conglomerates of Cannock Chase are of an exceedingly interesting character, and probably there is no other tract where they could be studied or examined with greater advantage. They, as is well known, are made up of an astonishing variety of pebbles, every pebble being more or less rounded, and moreover, largely intermixed with rolled fragments of Silurian and Carboniferous rocks, containing fossils of those formations. And it was in working up these deposits which first led me two years ago to visit the gravel-pits which belong to Lord Hatherton, at Shore Hill or Huntington, to which I have alluded. The conglomerates are here exposed by a section of from 80 to 100 feet, and they dip to the west at an angle of about twenty degrees. They consist of the ordinary groups of pebbles and irregular intersection of sandy rock, and at about the middle of the section occurs the copper ore, in the form of a green carbonate intermixed with the paste or cementing material in which the pebbles are set. The [illegible] does not occupy any definite position in the gravels, nor is it co fined to any particular horizon. It is sometimes met with in li blocks and by the [illegible] action of [illegible]-niferous Limestone or d pebbles in fragments [illegible] and even occasionally insinuates i into the interior of [illegible] fractured pebbles, and in places in quantities which, if [illegible] persistent, would be of g commercial value. As this is the copper area, so far as I h found, are not directly associated with lead, but about twenty beneath the copper-bearing beds the latter ore is found to occur in series of thin cementing lines in the gravels, and following th natural inclination of the beds. In one instance the gravels are in a light grey and greenish-yellow cement, in which are f traces of lead, iron, and aluminium soluble in acids. It is, therefore, to these conditions, the association of copper and lead ores with the Huntington gravels, that they owe their peculiar character as detri mental to the growth of weeds, and from which, but previously unknown circumstances they have a large demand as material for th formation and repair of garden roads and walks, the gravel having been sent as far as Ireland for this purpose.

During the early part of the present year the Fair Oak Collie Company, also acting under my advice, commenced sinking a p of shafts for coal four miles to the north-east of Huntington Gra Pits, about 2½ miles north of the West Cannock Colliery, half mile west of the valley fault to which I have alluded, and abo two miles west of the Brereton Collieries. These sinkings co mence in drift sands and gravel, which at a depth of eleven feet succeeded by Bunter conglomerates, and therefore, in new red sa stone. At a depth of [illegible] feet from the surface lead ore occurs large quantities, disseminated freely amongst the gravel, which coarse and set in an excessively hard calcareous conglomerate. is however by no means continuous or persistent in its occurren It extends only about half-way across the south side of the shaft some instances, but it is found at irregular intervals in larger smaller quantities, mixed up both with fine and coarse gravel, dow wards to a depth of 55 feet from the surface. At 75 feet in t shaft copper ore first shows itself, which in this case is distinc separated from the lead. In passing downwards both these o are found freely associated together, and in large quantities, wh so far by no means reach the percentage of the Huntington spe mens. In this particular instance—that is, the association of two ores—the Fair Oak ores differ from those of Huntington, though it is of course quite probable that this may not be so ground at present unexplored. The gravel and sandstone are b coarse and fine, and they have the peculiarity, by no means economic one, of being excessively hard and compact, and he difficult to get through. This is entirely due to the calcareous ferruginous properties of the cement or paste in which they are The Fair Oak copper ore is also a green carbonate, occasionally pa ing into malachite or carbonate and hydrate of copper, and th are also in some specimens traces of oxide of copper. The lead, which is more abundant than at Huntington, occurs in the form of ordinary galena or sulphide of lead, but so far no other ore, except manganese and iron, have been detected, although it is most probable that both cobalt and nickel, and possibly tin, may exist in small quantities.

With regard to the origin of these ores, or under what condition they were produced, I will not here venture an opinion. I believe they determine the lines of some important disturbance; but, however this may be, their occurrence at these particular and widely separated points is certainly curious, and worthy of investigation, and probably other sinkings in the conglomerates of the Chase will help to throw some light on the subject. How far they extend downwards in the conglomerates the present sinkings will of course determine; in August last, they had not been met with below 108 feet from the surface, but copper made its appearance much lower down. The Coal-measures I believe will be struck at about 240 feet from the surface, and I should not be surprised to find these ores mixed up more or less with the gravel and sandstone down to their base. I may remark that copper ore of this description occurs in Permian rocks near Barlaston and Trentham, and at other places in North Staffordshire, and it is also found in large quantities associated with lead, cobalt, and other commercial ores, in Keuper sandstone, at Alderley Edge, in Cheshire; but I myself am not aware that at any other locality than Cannock Chase have copper and lead ores been found in undoubted Bunter conglomerate in England. I do not in their present form, and in the face of richer deposits, attach much commercial value to them; but geologically they are of much interest, and it is these circumstances which have led me to publish the few facts I have been able to obtain in reference to them.

VI.—THE MICROSCOPIC CHARACTERS OF A SILO-CARBACID ROCK FROM CEYLON; AND THEIR BEARING ON THE METHYLOTIC ORIGIN OF THE LAURENTIAN "LIMESTONES."

By WILLIAM KING, Sc.D., Professor of Mineralogy and Geology in Queen's College, Galway.

THE rocks usually called metamorphic[1] may be conveniently divided into two great groups—Silacids and Silo-carbacids, depending on the nature of their respective acid constituent. The *first* comprises syenites, gneisses, and ordinary crystalline schists—all essentially composed of mineral silicates. The *second* includes ophites, urkalks,[1] and some others, which, in addition to siliceous minerals, contain more or less mineral carbonates.[2]

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[1] The term *metamorphic* is herein restricted to rocks that have become *structurally* changed or mineralized. I propose the term *methylosis* (from *meta*, change; and *hyl*, substance) to express the various *chemical* changes which certain rocks have undergone since their formation by eliminations of, or additions to (both processes acting simultaneously, or one alone) their original substances to a more or less extent. The changes are analogous to those of pseudomorphism in minerals. This last term has occasionally been applied in the case of rocks; but some have, with much reason, urged that it ought to be confined, as originally understood, to chemical changes in crystals unaccompanied by any alteration of their form. A term similar to methylosis (but coming from different roots) is in use among chemists: geologists, however, are not likely to confound the two. Methylotic rocks, I feel persuaded, will prove to be commoner than appears to be known. They are not altogether confined to metamorphic associations; as some—such as coal, magnesian limestone, chloritic, and

It is chiefly with the second group that the present communication is concerned.

Although a number of highly valuable researches on the microscopic structure of the silacid rocks have been published, it is remarkable that very little attention seems to have been paid to similar investigations in the silo-carbacid group. Excepting certain papers that have appeared respecting one of its members, noted for containing the so-called "Eozoon" (the constructors of which, however, took little notice of anything that was clearly of crystalline origin), geological literature presents a blank as regards the microscopy of the group; the more surprising, as, apart from the belief in the above reputed "organism," the silo-carbacid rocks form a subject of considerable importance in *theoretical* geology; the question as to their origin having evoked at different times some lively discussions, and the most opposite views. I cannot, therefore, too strongly recommend them for examination to investigators of micro-lithology.

Fortunately, the examination of the silo-carbacid rocks is comparatively inexpensive, and attended with uncommon facilities. No sections, unless for supplementary, or optical purposes, are required. Mere chips, after remaining in a weak solution of hydro-chloric acid for a few hours (decalcification, as it is called), will display under the microscope the siliceous minerals freed from the associated mineral carbonates, with every peculiarity of form, condition, and grouping, in a highly instructive manner.

In conjunction with my colleague, Dr. T. H. Rowney, I have lost no opportunity of late years in investigating the structure of these rocks; while in the joint memoirs we have published many of our observations are minutely described.[3]

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serpentinous argillites, etc.—are intimately associated with unaltered rocks. A deposit in Co. Antrim, agreeing with typical beauxite in being a hydro-oxyferriferous alumina (and which has been worked by Dr. Ritchie, of Belfast, who has kindly furnished me with specimens), is seemingly a methylotic product, derived from basalt by the elimination of silica, and the addition of water, etc.

[1] I adopt this name from Werner, though it is restoring one about as objectionable as *gneiss* and some others current in Geology. I have long thought of proposing the name *akerlyte* for a similar crystalline calcareo-siliceous rock, occurring at Aker in Sweden; but probably one of Brongniart's names, *calciphyre* and *hemitrene*, of a later date than Werner's, will prove to be a synonym.

[2] Apatite and magnetite occasionally prevail to such an extent amongst the Laurentian metamorphics of Canada as to form phosphatic and oxidic sections of the silo-carbacid group. There are other rocks present, in which mineral carbonates occur so sparsely as to merge them closely into the silacid group; on the other hand, it is conceivable that others exist in which the mineral silicates may be reduced to a very small per-centage.

[3] See Quarterly Journal of the Geological Society, vol. xxii., 1866; and vol. xxv., 69; also Proceedings of the Royal Irish Academy, vol. x., 1870; and *Id.*, new es, vol. i., 1871.

Ophites and urkalks respectively represent two sections—hydrous and anhydrous—into which the silo-carbacids may be divided. The first consists essentially of the hydrated siliceous mineral, serpentine and its varieties, more or less intermixed with mineral carbonates, chiefly calcite and dolomite. The second is constituted of anhydrous siliceous minerals, related to amphibole and pyroxene, associated with mineral carbonates. Various other species — silicates and carbonates, and some with different acids—are rarely absent in both sections.

The presence of serpentines, or of amphiboles, is readily indicated; the former by having usually a conchoidal, and the latter an even-plane (cleavage) divisional structure. Both kinds of minerals also occur in the granular, asbestiform, lamellar, and other conditions.

Silo-carbacid rocks seem to be seldom absent wherever metamorphism has played an important part; and, although undoubtedly of widely different geological ages, they are found most extensively developed in the very oldest systems, especially the Laurentian. It was on this account that Werner named the rocks of the anhydrous section urkalks.

During the present year several varieties of ophite and urkalk from India and Ceylon have come under my notice. They are of such interest in many respects that I hope to be able, along with my colleague, to describe them in detail on a future occasion. I have thought it necessary, however, to draw up the present preliminary paper, as some time may elapse before our observations on all these acquisitions are completed.

Captain Bayley, P. and O. agent at Galle, has kindly furnished me with the specimens from Ceylon, as well as a number of precious stones. The former were procured on an estate of his situated adjacent to and below the Haughton Plains. I am not in a position to speak of the mode of occurrence or geological age of the rock, which for some reason or other is called dolomite; but being evidently a member of the great metamorphic series, so remarkably developed in the island, it may very probably be Primordial.

As is the case with many of the so-called dolomites occurring in Canada and elsewhere, the rock under notice contains but an insignificant amount of any mineral carbonates; silicates being the predominant constituents.

By slightly decalcifying portions of it, the carbonates, principally calcite, are partially dissolved out, and the silicates remain. Under the microscope the latter are seen to consist for the most part of what appears to be wollastonite (silicate of lime), in irregular-sized grains confusedly aggregated, or occurring singly,—each grain being distinguished by its individual set of cleavage divisions. At first sight this mineral might be taken for malacolite (silicate of lime and magnesia)—a variety of pyroxene; but careful observations show that it has two prismatic cleavage intersections, which form a more compressed rhombic solid than the one belonging to the last-named mineral; the prism, in short, more closely resembles the primary of amphibole. Dr. Rowney has not yet had an opportunity of analyzing the mineral; but, considering it is slightly soluble in dilute hydrochloric acid, the solution gelatinizing when concreted,—that it has a somewhat pearly lustre, and is rather easily cut with the point of a knife, we are led to refer it to wollastonite rather than to any of the amphiboles: it moreover appears to agree with the former mineral in its cleavage.

The aggregations are generally in contact; but there are often separations between them varying much in width, and filled with calcite. The wide separations contain isolated aggregations, as well as single grains, of various sizes: those that have not dropped out or been detached consequent on decalcification remain partially imbedded in the undissolved calcite. Interspersed amongst both the wollastonite and calcite occur here and there microscopic gems of different kinds; while the common mineral silicates — serpentine, (?) chondrodite, and others—are occasionally present.

The precious stones, which appear to be variously-coloured spinels —purple principally, opalescent moon-stone, and green chrysolite, have no definite form; being spheroidal, egg-shaped, more or less cylindrical, or lobulated. They have polished surfaces, and seldom display cleavage. A few present traces of angles, edges, and planes, rendering it impossible to resist the conclusion that they are all defacetted crystals which have been acted on by solvents that penetrated their imbedding rock.

The same conclusion attaches to the wollastonite, as its various aggregations and single grains display the plainest evidences of waste, both internally and externally. Their cleavage divisions (each formed by two juxtaposed planes in *immediate* contact in minerals unaffected by disintegration) are of considerable width, and *filled with calcite.* The single grains, also, are without any definite form; and, although their cleavage is well suited for producing the bounding planes of a rhombic prism, their exterior is rarely otherwise than jagged, variously excavated, or irregularly rounded. Isolated fragments, reduced to mere skeletons, occur as plates, rods, films, and shreds; or under a variety of forms—arborescent, curving, and infundibular. When the latter are in clusters—with, as is often the case, a radiating, diverging, or brush-like arrangement in each cluster—their beauty, increased by their translucency and pearly lustre, altogether surpasses description. And the sight is still more striking where the field of view is additionally bedecked with different coloured gems.

The configurations of wollastonite vividly recall to my mind the typical examples of what have been erroneously considered as "casts of tubuli of the canal system of Eozoon." Finer examples are not to be seen in the Canadian ophites. In these rocks they *invariably* consist of silicates,—generally serpentine, and occasionally a variety of amphibole, or of pyroxene.

It remains to be mentioned that the Ceylon rock has precisely the same characters as a spineliferous urkalk (akerlyte) occurring at Aker in Sweden. The principal mineral silicate of the latter was formerly considered by Dr. Rowney and myself to be malacolite; but we

ow strongly inclined to regard it as wollastonite: be this as it
the beautiful configurations it has given rise to, and which
been elsewhere noticed by us,[1] are strictly *identical in every*
with the previously described examples. The Aker urkalk
not appear to be so gemmiferous as the one from Ceylon, it
g only yielded to us violet-coloured spinels and fragments of a
vitreous mineral that looks like chrysolite.

late Dr. Davy, in his memoir, "On the Geology and Miner-
of Ceylon," written in 1818, and published in vol. v. of the
actions of the Geological Society, notices a "calcareous spar
y of Gneiss," and a "dolomitic rock": both are probably
r to the urkalk described in this communication. It would
r from his account that the silacid rocks form the matrix of the
ous precious stones found in the alluviums of Ceylon. I
that carbuncles, topazes, chrysoberyls, etc., may have been
d from the gneisses, and the usually associated crystalline
s; but from what the urkalk reveals under the microscope I
d to believe that calcitic or dolomitic rocks of the kind have
d the more valuable gems. I cannot speak with confidence
apphire is present in any of Captain Bayley's specimens; but
s found in the urkalks of the United States, Ural, Hindostan,
, and other countries, the fact may be accepted as strongly
matory of my belief.

has long been known that the silo-carbacid rocks contain a
y of minerals with the angles and faces of their crystals
ntly in a rounded condition. Some have suggested that this
arity is the result of partial fusion; while others contend that
the effect of the solvent action of heated watery solutions.
latter is the view which has been adopted by myself and
gue. I am not aware, however, that any one, except ourselves,
fered the solvent theory to account for the present form of the
s configurations in serpentine, malacolite, and wollastonite,
terizing ophites and urkalks; or that the process it involves
ually accomplishes their total removal. Careful observations
as it were, the process in operation in these rocks,—com-
ng with the disintegration of their component mineral silicate,
t, gradually removing it (isolated portions of which, through
lar decretion, are made to assume all the imitative shapes
teristic of the configurations), with simultaneous replacement
lomite, or calcite,—and ceasing on its complete elimination.
henomenon is evidently due to chemical changes or methylosis,
quent on the presence in the rock of a permeating solvent
ning carbonic acid (? atmospheric in its origin), simple, or in
nation—an agent fully capable of displacing the silica of the
urations, and substituting a new constituent.

thermore, many geologists have been struck with the peculiar
s of occurrence of silo-carbacid rocks,—intrusive or eruptive-
onfusedly crumpled between comparatively undisturbed beds,

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[1] Proceedings of the Royal Irish Academy, vol. x., 1870.

disconnected blocks and lenticular sheets,—peculiarities held to be inexplicable on the idea that they are in any way related to sedimentation. While some have left the difficulty to be cleared up by future investigations, a few who have studied pseudomorphism in minerals meet it by contending that in the cases referred to the same phenomenon, accompanied by new mineral arrangements, has been developed.

So much may be urged in favour of this view, that I, with my colleague, have decided on adopting it to explain, not only the origin of urkalks and ophites, including the rocks last noticed; but also the "great beds of limestone," which in Canada characterize the Laurentian system. The same laws by which felspar, garnet, and other mineral silicates are changed into calcite (cases of the kind being well known), can operate under the necessary conditions—say, hydro-plutonic—in converting widespread strata of silacid rocks into the above so-named beds. Most of the latter, there are strong grounds for believing, are urkalks: some of them, however, may be so sparsely charged with mineral silicates as to justify to some extent, and in their particular case, the name that has been given to the entire series by the Canadian geological surveyors.

In considering the order of the changes which the Laurentians, as a whole, have passed through, according to the doctrine under discussion, it must not be overlooked that this great Rock-system includes, besides its vast beds of every variety of syenite, gneiss, etc., other members which, although essentially formed of the minerals constituting such beds, contain chrysolite, loganite, serpentine, malacolite, chondrodite, pyrallolite, talc, pargasite, magnetite, wollastonite, apatite, etc.,[1] with appreciable amounts of mineral carbonates:[2] the members alluded to may be referred to the *first* stage. Typical ophites and urkalks, still largely made up of the above mineral silicates, but in which there is a notable increase of dolomite, or calcite, ought to be considered as belonging to the *second* stage. While the purer "limestones," in which it may be assumed the mineral carbonates have gained the ascendency, will have to be allocated in the *third* stage.

In conclusion, taking for granted that the Laurentian rocks are metamorphosed sediments (silicates) derived from earlier or preexisting masses of similar chemical composition, I have no hesitation in accepting the conclusion—that the methylosis herein roughly sketched out, or some analogous process, began after the sediments, affected by it, had become mineralized into syenites, gneisses, and the like;[3] and ended by their being converted into "limestones."

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[1] Whatever particular view may be taken of pseudomorphic processes, I am strongly inclined to believe that the various minerals mentioned in the text are secondary products, resulting from chemical changes in syenites, gneisses, etc.

[2] Kalk-diorite and kalk-glimmerschiefer of the Germans seem to belong to this group. Kalk-diabase and lherzolite appear to be younger rocks, whose calcite may be original, or it may have been derived from limestones older than themselves; and I am disposed to admit that much of the calcitic urkalk (not the dolomitic) of Connemara, apparently Lower Cambrian in age, may be a simply metamorphosed calcareous rock.

[3] It is even probable that chemical changes commenced while the Laurentian

VII.—Biographical Notice of John Farey, Geologist.

By W. Stephen Mitchell, LL.B., F.L.S., F.G.S.

Sources of Information.—The short notice in the "Monthly Magazine" for Jan.–June, 1826, is, so far as I know, the only printed source from which any account of his life can be obtained. The notices in the "Annual Biography and Obituary," 1827, the "Annual Register," 1826, and "Rose's Biographical Dictionary," are but reprints from this, with some omissions and verbal alterations. His name does not, I believe, appear in any other biographical dictionary or register.

His Life.—He was born at Woburn, in Bedfordshire, in 1766, where he received a common school education; but showing studious habits he was at sixteen sent to a school at Halifax, in Yorkshire. Here the master was so pleased with him that "he gave him gratuitous instruction in mathematics and philosophy." [Query, What would the term 'philosophy' embrace?] He also studied drawing and surveying, and was recommended to the notice of the celebrated Mr. Smeaton. He had the good fortune to become known to the late Duke of Bedford, and in 1792 was appointed his steward, and lived at Woburn till the Duke's death in 1802. He married early, had a large family, and died at his house in Howland Street, London, Jan. 6th, 1826.

This is all we can learn from the Monthly Magazine. We are not told what was the effect of his introduction to Smeaton, nor what became of him after the death of the Duke. We know that during portions of the years 1807–10 he was engaged on a survey of "the agriculture and minerals of Derbyshire," and in his Report to the Board of Agriculture, published in 1811 (vol. i.) and 1813 (vol. ii.), he is described on the title-page as "Mineral Surveyor, of Upper Crown St., Westminster."

What important works Mr. Farey may have executed as a Surveyor I do not know. But Mr. Farey's publications have an interest for geologists from the fact that they contain the first printed reference to the discoveries of Wm. Smith, the first published geological map [that of the county of Derby], and the first printed list of the sequence of strata based on palæontological data. The paper in which he first refers to the discoveries of Smith is one in the Phil. Mag., vol. xxv. (1806), pp. 44–49, "On the Stratification of England: the intended Thames Archway," etc. Mr. Farey had met with Wm. Smith in 1802, and had learned from him the results of his discoveries.

Mr. Smith, in a letter to Mr. Richardson, of Bath, dated from Woburn, Feb. 1, 1802, writes: "The last week was spent in surveying distant properties belonging to the Duke, and investigating

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sediments were undergoing metamorphism. Mr. J. Arthur Phillips has made known some highly valuable and suggestive facts, which seem to show that Cornish Killas or slate rock is marked by a decrease of silica and alumina, and an increase of water and magnesia (or lime in some cases), the more it assumes a metamorphic condition—thus passing into a substance approaching to serpentine. (See Philosophical Magazine, February, 1871.)

the country for many miles in different directions as far as Aylesbury, accompanied by the land steward (Mr. Farey) and Mr. Bevan, of Leighton, ... to examine the practibility of my arrangement of strata. . . . . . . They both returned complete converts,"—Phillips's Memoirs of Smith, p. 40.

From this time Mr. Farey was an ardent follower and warm advocate of Wm. Smith. Dr. Fitton, in an article communicated to the Edinburgh Review, vol. xxix., No. 58, 1818, writes: "Mr. Farey, the other . . . . friend of Mr. Smith, is himself a geological observer of great activity and unwearied perseverance; and if zeal were the only qualification of an editor, there could not have been any person better fitted for the task. But the patronage of this gentleman is really a little too vehement, and of such a sort that if we wished to insure the failure of a valuable performance, we should begin by recommending it to his protection."

He wrote some very strong articles in support of Wm. Smith's claim to consideration as an original discoverer: for example, his papers in the Phil. Mag. on "Mr. Smith's Claims stated," "Geological remarks on Messrs. Cuvier and Brongniart's 'Environs of Paris,'" etc., etc.

In 1811 Mr. Farey gave to the world a more careful account of the strata of England, as ascertained by Mr. Smith. He had been engaged by the Board of Agriculture to write the General View of the Agriculture and Minerals of Derbyshire for their County Reports, which they were then having made for the whole of England. There had been already a Report on Derbyshire by Mr. Brown, but this was superseded by the Report of Mr. Farey, which was therefore called a reprint. This work was written according to a plan laid down by the Board. But in Section 4, before the Description of the Soils, he inserted a series of paragraphs with the following titles[1]:—

"The Knowledge of Stratified Masses important" (p. 105).

"Stratified Masses defined" (p. 106).

"Sections, or Cutting of Stratified Masses, considered" (p. 106).

"Application of the above to the Stratification of England, according to Mr. Wm. Smith, of Buckingham Street" (p. 108).

"General dip, or Declination of Strata towards the S.E. (p. 108).

"Continued Basset of Strata across the Island" (p. 108).

"Discrimination of Alluvial Matters" (p. 109).

"Particular Organic Remains peculiar to particular Lamina of Strata" (p. 109).

"Order of the British Series of Strata" (pp. 111 to 116).

"Bagshot-heath Sand, London Clay, and Blackheath Sand" (p. 111).

"Flinty Chalk, Hard Chalk, Chalk Marl" (p. 112).

"Aylesbury Limestone, Sands, Clays; Sussex Marble; Woburn Sand" (p. 112).

"Clunch Clay; Bedford Limestone, Clay; Barnack Ragstone, Collyweston Slate, Sand, Bath Freestone" (p. 113).

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[1] Farey's "Derbyshire," contents, p. xxviii.

"Portland, and Bath, and Ketton Limestone; Northampton Stone, Sands, Clays; Maidwell Limestone Clay" (p. 114).

"Lias Clay and Limestone Strata" (p. 114).

"Pozolanic, or Water Lime of Barrow-on-Soar, Leicestershire," (p. 114).

"White Lias, Balderton Sand, Red Marl" (p. 115).

Followed by a "Theory of Dislocated and Denudated, or Cut Stratified Masses," which is illustrated by fifty-six coloured drawings.

I do not know why Farey stopped at the Red Marl in giving an account of Smith's knowledge of the Strata, for Mr. Smith certainly had a knowledge that Coal and the Limestone come underneath.

At the end of the first volume of Sowerby's Mineral Conchology is a Supplementary Index,[1] arranging the shells described therein according to the several strata in which they are found imbedded, from the newest towards the oldest in the British series. The strata referred to are those as classified in Mr. Smith's map. This was kept up in subsequent volumes.

The Royal Society Catalogue contains a list of Mr. Farey's papers, to which he signed his name, among them are many on music. But there are many anonymous papers of his besides, such as those in the Monthly Magazine. I shall be glad to know if any one can say whether he did not write some of the articles in Rees' Encyclopædia, *e.g.* "Grand ridge," "Strata," etc.

As he was so warm a supporter of Smith, it seems strange that the memoir in the Monthly Magazine contains no reference to his having received his first geological knowledge from him, but, on the contrary, says he obtained his success from following the proposals of the Duke of Bedford. In many of the writings about this date there seems to have been an intentional suppression of reference to Smith in places where it might justly be expected. Can any explanation for this be offered?

NOTICES OF MEMOIRS.

I.—GEOLOGICAL SURVEY OF INDIA.

1.—MEMOIRS OF THE GEOLOGICAL SURVEY OF INDIA, Vol. VIII., Part 1. 1872.

THIS Part comprises an elaborate Memoir by Mr. William King, jun., B.A., on the Kadapah and Karnul Formations of the Madras Presidency. This series of rocks has been hitherto known by such names as the "Diamond Formation," "Clay Slate Formation," and "Old Red Sandstone," names which have proved inapplicable, therefore those of the districts they occupy have been applied for the two formations under which the different groups of rocks can be classed. Mr. King states there are good grounds for believing that they may eventually turn out to be partly representative of the great Vindhyan series of India, and of a possibly underlying formation. It is not certain that they are of Palæozoic age; they may even be older than this, but according to present knowledge, they are Azoic, for no traces of life have been found in them. These Kadapah and Karnul rocks rest upon the Crystalline rocks or Gneissic series, which occupy a narrow belt of country all round the outermost boundaries of the newer rocks.

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[1] "For this supplementary index I am (says Sowerby) indebted to my indefatigable friend Mr. John Farey."

They consist of a great succession of Clay-slates, Quartzites, Limestones, and Shales, with Traps, and constitute two unconformable series, the older of which is largely developed in the Kadapah (Cuddapah) district, while the younger is developed in the Karnul (Kurnool) district.

After pointing out the physical structure of the country, Mr. King describes the two formations in detail.

In the Karnul formation there is a series of Quartzites, Sandstones, Grits, and Pebble-beds, which might be called the Diamond-bearing Group, as until lately there was no knowledge of diamonds having been found in any other set of rocks of either the Karnuls or Kadapahs. The old diamond-workings near Oostapully, on the left bank of the Kistnah, have however been visited by Dr. Oldham, who considers that they were executed in quartzites of the Kadapah series. A local name has, therefore, been adopted for the diamond-series of the Karnul formation—it is called the Banaganpilly Group. This group forms a capping, 10 to 20 feet in thickness, resting unconformably on a much older set of shales and traps. This capping is pierced by shafts 15 feet or less, from the bottoms of which horizontal galleries are driven to get at the seams of diamond gangue. While the rocks of this group are hard and vitreous where exposed to the atmosphere, down in the shafts, owing largely to the confined moisture, the rocks are quite unaltered, and it is in more or less clayey and shaly seams of pebble-beds that the diamonds are found.

The main resources of the Karnul and Kadapah formations are diamonds, copper, lead, iron, and building materials. Their mode of occurrence and economic value are pointed out, and where necessary the report is illustrated with sketches and geological sections. It is essentially a volume of practical geology, the total absence of organic remains depriving the formations of a good deal of the interest they would otherwise have to those not specially interested in the economic geology of the district. Nevertheless the field geologist will find much to interest him in the descriptions of the rocks, and in the explanations of the many complications of structure which they present.

2.—THE GEOLOGY OF MOUNT SÍRBAN, IN THE UPPER PUNJÁB.

By W. WAAGEN, PH.D., and A. B. WYNNE, F.G.S., Geological Survey of India.

THIS mountain, which has an elevation of 6243 feet, with an elongated oval base, is one of the most lofty of the Hazára Hills, a portion of those which form the outer spurs of the north-western

Himalaya, bordering the Upper Punjáb. The geological structure is interesting, as it affords an epitome of much of the geology of the north-west frontier of British India, nearly the whole series known being present; those unrepresented being chiefly the older crystalline and the newer portions of the Tertiary rocks.

The following is the succession in descending order :—

6.—Nummulitic.	Thick limestones with some shales—fossils in places.
5.—Cretaceous.	Thin-bedded limestones — apparently without fossils. Impure ferruginous sandy limestone, weathering rusty —fossils.
4.—Jurassic.	Black Spiti shales.
	Unconformity.
3.—Triassic.	Thin-bedded limestones and slaty shales. Dolomite limestone; fossiliferous (*Megalodon* and other) beds.
2.—Below the Trias.	Hæmatite, dolomite, quartzite, sandstone, and breccia.
	Unconformity.
1.—Semi-Crystalline.	Attock (?) slate.

Two, if not more, unconformities have been observed—one between the Jurassic and Triassic series, and the other between the semi-crystalline rocks and the beds above them.

1.—The lowest or Attock slate series are unfossiliferous, but may possibly be of Silurian age.

2.—The succeeding series is also unfossiliferous, and is totally unconformable to the beds below them. They consist chiefly of red sandstones, shales, and Quartzitic Dolomites in the lower part; the upper being composed of Dolomites often siliceous, and above which are a third group composed of Hæmatitic rocks, sandstones, shales, and breccias.

3.—The Triassic series comprises two divisions, which are either dolomites or limestones; the lower one containing *Megalodon, Dicerocardium, Chemnitzia,* and *Gervillia;* and the upper one with *Nerinæa, Neritopsis, Astarte, Opis, Nucula,* etc.

4. The Jurassic beds of Sirban are represented by black shaly clay-beds, well known in Himalayan geology as "Spiti shales." They are not rich in fossils, but fragments of *Belemnites, Inoceramus,* and *Corbula* have been found.

The unconformity of these shales to the underlying Triassic series is marked by the erosion of the limestones, which are also pierced by the crypts of boring Mollusca.

5. The Jurassic series are overlain, apparently conformably, by hard, rusty, calcareous sandstone, with Cretaceous fossils, chiefly Cephalopods, and a few Gasteropods. The Ammonites belong chiefly to the *Cristati* and *Inflati* groups, besides several species of *Ancyloceras, Anisoceras,* and *Baculites,* as well as numerous large *Belemnites.* These fossiliferous beds are considered to be the representatives of the Middle and Upper divisions of the Cretaceous rocks.

6. Overlying these is a massive grey and blackish Limestone alternating with zones of dark shale, and referred to the Nummulitic formation. It is of great thickness and much contorted, and its physical features are deeply-excavated gorges and ravines, high

cliffs, and great subsided masses, producing much complication of slippage often exceeding in amount the throw of genuine faults.

The fossils are not well preserved, but some beds are largely composed of *Nummulina* and other Foraminifera, together with some Mollusca more or less imperfect.

Sirban is of special interest as being a locality south-west of the first great crystalline axis of the Himalaya: of which region the palæontological geology is as yet little known, and affords a means of comparing the formations on both sides of the above-mentioned axis. In order to do this, it will be useful to abstract from the papers of Dr. Stoliczka a tabular *résumé* of the Himalayan formations placed in comparison with those of Sirban:

SIRBAN.		DR. STOLICZKA: SPITI.	
NUMMULITIC		....	
CRETACEOUS ...	Unfossiliferous limestone	Chikkim shale Chikkim limestone	CRETACEOUS.
	Fossiliferous zone ...	... ... ?	... ...
	... ... ?	Gieumal sandstone	JURASSIC.
JURASSIC	Spiti Shales	Spiti Shales ...	
Unconformity.			
TRIASSIC	Thin-bedded limestone and slaty shale... ...	Tagling limestone	TRIASSIC.
	Dolomite and *Megalodon* limestone	Para limestone	
BELOW THE TRIAS	Siliceous Dolomite ...	Lilang series ? ?	
	Red Sandstone and shale	... ... ?	
Unconformity.			
	... ...	Kuling series ? ...	CARBONIFEROUS.
		Muth series ?	? ... SILURIAN.
SLATE SERIES....	Attock Slates	Babeh series ?	

It is apparent that though there is a general similarity, the two regions on opposite sides of the crystalline axis show several points of difference, though not so great as to deprive us of hope that they may be brought into closer accordance by subsequent researches. At present the main differences are rendered greater by the occurrence of marked unconformities in one region unrecorded in the other. The area around Sirban has been subjected to great and continuous disturbance during long periods of time, and it would be highly interesting, if possible, to find out whether these periods of disturbance coincide with the eruptions of the volcanic rocks known to exist in the interior of Cashmere.

3.—ON THE OCCURRENCE OF *AMMONITES*, ASSOCIATED WITH *CERATITES* AND *GONIATITES* IN THE CARBONIFEROUS DEPOSITS OF THE *SALT RANGE*. By WILLIAM WAAGEN, Ph.D., Geological Survey of India.

IN this Memoir, Dr. Waagen announces his discovery of the association of *Goniatites*, *Ammonites*, and *Ceratites* in the same bed with *Productus*, *Athyris*, etc., and referred provisionally to the

Upper division of the Carboniferous formation. The locality of these fossils is near Jali, north of Shabpoor, on the southern slope of the Salt-Range. Although the associated fossils, such as *Athyris Roissyi*, *A. subtilita*, *Productus costatus*, and *P. longispinus*, indicate a Carboniferous aspect, other fossils, as *Stropholosia Morrisiana* and a *Terebratula*, closely resembling *T. elongata*, are Permian forms. Dr. Waagen is inclined to place the strata containing these fossils at the limits between the Carboniferous and Permian periods. The occurrence of these three Cephalopodous genera was first observed by Münster in the St. Cassian Beds of Triassic age.

II.—A BOOK ABOUT WILLIAM SMITH AND THE SOMERSETSHIRE COAL CANAL, WITH AN ACCOUNT OF THE ORIGIN OF STRATIGRAPHICAL GEOLOGY IN ENGLAND. By W. STEPHEN MITCHELL, LL.B., F.L.S., F.G.S.

MR. MITCHELL announces that he is about to publish by subscription a work on William Smith and his discoveries in Somersetshire, which led to the rise of the science of stratigraphical geology in England.

The book will form a useful addition to geological literature, as it is designed to bring together into one record all the information that can be obtained of the geological work of the "Father of English Geology."

The way in which his discoveries along the Somersetshire Coal Canal Valley are illustrated deserves special commendation.

The reader has laid before him, in a series of consecutive photographic views, the physical features of the valley, and in a series of coloured lithographs the arrangement of the strata. Those not accustomed to field-work can with this *coup d'œil* understand the stratigraphical arrangement better than by trudging over the ground itself. The facts are presented so simply that there is no difficulty in understanding them. Doubtless it will be a book of great service to those commencing the study of geology. In these days of cramming for competitive examinations there are many who learn off "tables of strata," and commit to memory "characteristic species," who have very erroneous ideas of what these strings of names really mean.

Nearly all our classificatory geology is based on the method of William Smith, and a clear understanding of his observations and deductions is the surest way to understand the subsequent modifications and to trace the reasons for opinions now held. The work will also prove of interest to the general geological reader, and the illustrations alone have an attraction for those who may not care for the subject-matter. We expect it will be well received in Somersetshire, for it cannot often happen that there is an opportunity of obtaining so many views at so small a sum (21*s.*).

We know that at the price proposed the work can only be issued by securing a large number of subscribers, which we trust the author may succeed in obtaining.

III.—GEOLOGICAL DIAGRAMS AND MODELS.

TABLE OF BRITISH SEDIMENTARY AND FOSSILIFEROUS STRATA. By HENRY WILLIAM BRISTOW, F.R.S., F.G.S., Director of the Geological Survey of England and Wales. With a Description of Life Groups and Distribution, by R. ETHERIDGE, F.R.S. (Stanford.)

GEOLOGICAL MODELS OF ENGLAND AND WALES. By WILLIAM TOPLEY, F.G.S., Geological Survey of England and Wales; and J. B. JORDAN, Mining Record Office. (Stanford.)

WHILE the progress of geology is revealed in one way by the numerous manuals and text-books, it is shown in another way by the charts, tables, maps and models, which are from time to time constructed and published, in accordance with the advancement of the science. Appeals made to the eye are always appreciated by the student, and they are indeed essential as a method of instruction. A glance at a geological map or section will explain more than many pages of print; but properly to understand these, a good table of strata is necessary. Of course our small geological maps of the British Islands give tables of all the stratified rocks, showing their order of succession, but these cannot furnish much detail, and when we take maps on a larger scale, of course we cannot have representations in them of the whole series of strata. A table showing, not only the minor divisions of the British sedimentary and fossiliferous strata, but also the local divisions which have been made, as in the Inferior Oolite of Gloucester, the Midland counties, and Yorkshire; or in the Silurian rocks of Wales and the Lake district; is an essential diagram in the hands of all geologists. Such a table has just been prepared by Mr. Bristow, which is published by Stanford. In it are embodied all the latest modifications in our classification of strata, and it is as a table of classification that it will be most appreciated, because it does not furnish the notes on the economic uses of the rocks or their characteristic fossils, which are to be met with in other geological charts. It contains, however, a very useful summary of the life groups by Mr. Etheridge, arranged zoologically, and then giving their geological distribution. This table will be found of great service to the student while reading a geological manual; and in illustrating the succession of our rocks as they are depicted on our geological maps it will be found of great aid.

A geological map is, however, rarely understood, save by the geologist; for among those who are not adepts much ambiguity prevails as to the reason of the irregular shapes of the many colours on our maps. The relation between the form of the ground and its geological structure is one of the great doctrines of geology, and a knowledge of this adds greatly to the interest and understanding of a map. The small models long ago published by Mr. Sopwith were admirable as methods of instruction; but now we are not satisfied with these—a grander work must be accomplished—the whole of England shall be modelled, we are told, by Mr. Topley and Mr. Jordan. This undertaking is to comprise about sixteen blocks,

measuring each twenty-five inches by seventeen inches, and on the scales of four miles to an inch horizontal, and 2000 feet to an inch vertical. They are to be constructed from the published information of the Ordnance, Admiralty, and Geological Surveys, etc., and they will clearly indicate by relief the principal physical features of the country, and being coloured geologically, according to the different rocks exposed at the surface, they will show the relation between geological structure and physical features, and at the same time exhibit in a way unequalled at present, the meaning of our geological maps. Editions will be issued, showing by colour the river basins, rainfall, registration districts, etc., so that they will prove most useful not only as educational models, but will also be very serviceable to military men, engineers, and even medical men, for the relation between health and geology is occupying a great deal of attention at the present day. Special models of the Wealden district, and of the Thames basin, are to be ready early in January.

IV.—Silliman's American Journal for November last contains the following interesting palæontological discoveries:—

1. Discovery of Fossil Quadrumana in the Eocene of Wyoming. By O. C. Marsh.—An examination of more complete specimens of some of the extinct Mammals already described by the writer from the Eocene deposits of the Rocky Mountain region clearly indicates that among them are several representatives of the lower Quadrumana. Although these remains differ widely from all known forms of that group, their more important characters show that they should be placed with them. The genera *Limnotherium*, *Thinolestes*, and *Telmatolestes*, especially, have the principal parts of the skeleton much like some of the Lemurs, the correspondence in many of the larger bones being very close. The anterior part of the lower jaws is similar to that of the Marmosets, but the angle is more produced downward, and much inflected. The teeth are more numerous than in any known Quadrumana. Some of the species have apparently forty teeth, arranged as follows: Incisors $\frac{2}{2}$?, canines $\frac{1}{1}$, premolars and molars $\frac{7}{7}$. A full description of these interesting remains, the first of the order detected in this country, will be given by the writer at an early day.

2. Note on a New Genus of Carnivores from the Tertiary of Wyoming. By O. C. Marsh.—Additional remains of the large Carnivore described by the writer, on p. 203, *op. cit.*, as *Limnofelis latidens*, show clearly that it represents a genus quite distinct from *L. ferox*. The canine and premolars of the lower jaw somewhat resemble those in the Hyæna, but there were only two incisors in each ramus. One of these is large, and close to the canine. Inside and partially behind this, is a cavity for a second and smaller incisor. The remaining teeth preserved are especially broad and massive. The first lower premolar is separated somewhat from the canine, and is inside the line of the teeth behind it. The remains now known

indicate an animal about as large as a lion. The genus they represent may be called *Oreocyon*, and the type species, *Oreocyon latidens*.

3. NOTICE OF A NEW REPTILE FROM THE CRETACEOUS. By O. C. MARSH.—An interesting addition to the Reptilian fauna of the Cretaceous shale of Kansas is a very small Saurian, which differs widely from any hitherto discovered. The only remains at present known are two lower jaws, nearly perfect, and with many of the teeth in good preservation. The jaws resemble in general form those of the Mosasauroid reptiles, but, aside from their very diminutive size, present several features which no species of that group has been observed to possess. The teeth are implanted in distinct sockets and are directed obliquely backward. There were apparently twenty teeth in each jaw, all compressed, and with very acute summits. The rami were united in front only by cartilage. There is no distinct groove on their inner surface, as in all known Mosasauroids. The dentigerous portion of the jaw is 41 mm. in length, its depth below the last tooth is 5 mm. and below the first tooth in front 3 mm. The specimen clearly indicates a new genus, which may be called *Colonosaurus*, and the species may be named *Colonosaurus Mudgei*, for the discoverer, Professor B. F. Mudge, who found the remains in the Upper Cretaceous shale of Western Kansas.

REVIEWS

I.—A TREATISE ON THE BUILDING AND ORNAMENTAL STONES OF GREAT BRITAIN AND FOREIGN COUNTRIES. By EDWARD HULL, M.A., F.R.S. (London: Macmillan & Co., 1872.)

SINCE the valuable Report in 1839 of the Commissioners appointed to inquire into the qualities of the stone to be used in building the New Houses of Parliament, no special treatise has appeared on the subject. Even that very useful Report is to some extent limited in its scope, as it was not considered necessary to extend the inquiry to granites, porphyries, and other stones of similar character, on account of the enormous expense of converting them to building purposes in decorated edifices, and from a conviction that an equally durable and more eligible material could be obtained from among the limestones and sandstones of the kingdom. Hitherto the chief information in this country on building stones has had to be sought for in the works on architecture, engineering, and masonry, or scattered through the journals of societies, or geological manuals, and therefore not systematically or scientifically treated in any separate work. Two important works in French on the subject must, however, be noticed, the "Technologie du Bâtiment," by M. T. Chateau; and "Matériaux de Construction," by M. Delesse. With the view of supplying this deficiency in our own language, Prof. Hull has brought together a vast mass of practically useful and interesting information on the building and ornamental stones, both of our own and foreign countries; the different materials being arranged ac-

ling to their geological distribution and mineral character, and ir application in ancient and modern structures illustrated.

:he study of the more solid building materials is of considerable rest and importance, either in regard to their applications, or in ition to their origin. Under the former head may be considered, The proximity of the source and nature of the material; 2nd, ability; 3rd, Tint or colour; 4th, Change of colour by exposure weathering; 5th, Capability of absorbing water; 6th, Resisting ght or crushing power. All these are points which more or less uence the selection. Thus the contrast of the cities of London Manchester with those of Paris and Edinburgh, or why the ner are chiefly of brick and the latter of stone, are examples of proximity of certain geological conditions in both cases. The ndance of brick-earth and tile-clays are a marked feature in the nity of London, and have therefore influenced the street archi- ure, whilst, as Prof. Hull remarks, "the presence of the Carbonifer- sandstones in the immediate vicinity of Edinburgh and Glasgow e greatly contributed to the substantial character of the dwelling- ses, as well as of the public buildings, of these cities,—a character ich strikes the eye of a visitor on arriving from the great brick- ned cities of England." So, again, the Tertiary limestone of is has a pale yellowish tinge, admirably adapted for street archi- ure under a smokeless sky; and no one can fail to observe how ch of the beauty of the noble public buildings, and scarcely less le ranges of houses, in the principal streets of this queen of es, is due to the chaste purity of the stone, and its capability of ng employed either in massive structures, or in those of a more ate character.

)n the other hand, the public buildings of Oxford are a marked ance of durability and decay in the materials employed; thus, Headington limestone, obtained within the immediate vicinity of 'ord, and of which nearly the whole of the churches, colleges, other public buildings, have been built within the last three turies, are in a deplorable state of decay, so as in some instances have caused all traces of architectural decoration to disappear; ilst the ancient parts of the Cathedral, Merton College Chapel, w College Cloisters, of the 12th, 13th, and 14th centuries, pectively, built of the shelly Oolite, belonging to the lower part he Great Oolite, from Tainton, fifteen miles distant, and Burford, generally in a good state of preservation.

ieologically considered, the building stones of our large cities are instructive, as they afford examples of the different origin of k masses; thus the granites and porphyries are igneous rocks, the es and statuary marbles are metamorphic, the limestones are mical and organic, the cement stones are in part concretionary, the bricks and tiles are artificially metamorphosed clays and n, either of marine, drift, or freshwater origin.

ls before stated, the work is chiefly devoted to the stony materials architecture, and these are clearly and scientifically arranged by f. Hull in thirteen parts, the first of which comprises a general classification of the crystalline and other rocks, with short descriptive characters of each. The author adopts the views of Durocher and Bunsen, rather than that of Zirkel, for the division of the plutonic and volcanic rocks, according to the proportions of silica they contain, viz. into acid or highly silicated, and basic or less silicated rocks; the former comprising granite, syenite, quartz-porphyry, felstone, trachyte, phonolite, pitchstone; the latter, or basic, including porphyrite, diorite, melaphyre, diabase, basalt, dolerite, etc.

The succeeding parts ii. to v. contain the Granitic, Porphyritic, Greenstone, and Serpentinous rocks, followed by parts vi. to xiii. on Marbles, Alabaster, the Calcareous and Sandstone groups, the volcanic building stones, slates, with one on the rarer ornamental stones, as Fluor spar, Malachite, and the Quartz group. Under each division a great variety of useful and interesting information is given, with regard to their distribution in the British Isles, Europe, and other countries, as well as the architectural and ornamental uses to which they have been and may be applied. Among the more interesting chapters are those devoted to the marbles and limestones, which, from their great variety in colour, pattern, and structure, are amongst the most beautiful rock productions in nature; and from their being found in many formations, and widely distributed, have been largely used in ancient and modern times, both in this country and on the Continent.

The concluding observations in the work are devoted to the physical and chemical characters of building stones, the mode of determining them for general purposes, and their selection with special regard to climate, either dry or humid, or the nature of the atmosphere, whether pure, smoky, or acid, followed by a table constructed by Mr. C. H. Smith, showing the weights of a cubic foot of specimens fairly representing all the varieties of building stones used in this country and their localities, to which might have been added the cohesive strength, specific gravity, and absorbent power, as is shown at p. 46 of the Commissioners' Report.

Some few exceptions can be taken to the general character of the book. Here and there certain omissions occur, or fuller details are not given, which however may have been intentionally omitted, such as the great variety and number of the Devonian and other newer marbles and limestones of the Pyrenees, some of which were known to the Romans, worked at St. Gaudens, Luchon and other places, and exported to this country and America; the Eocene limestones of the Isle of Wight used in the ecclesiastical buildings of the southern counties, and the Lower and Middle Eocene siliceous sandstones (Sarsen stones), of which Kit's Coty House, Stonehenge, etc., are constructed, and to which geologic period belong the Hampden stone used about Aylesbury. Opinions may differ as to the position of the limestones referred to the Great Oolite of Ancaster, Ketton (*Ketton*, pp. 210-327), Casterten, and Barnack, which have contributed so largely to the beauty of the numerous churches and mediæval structures of Lincolnshire, Ely, Cambridgeshire, and Northamptonshire, and which are now being chiefly used for the additional buildings to the New Museum and Colleges at Cambridge.

We are glad to find the author recognizes the value of microscopical research as partly essential to the determination of the composition of igneous and other rocks, and to which attention has been so well directed by the labours of Prof. Zirkel and Mr. D. Forbes; and we think that additional illustrations under this head, instead of *one* only, would have enhanced the utility of this acceptable volume.

II.—GEOLOGY OF EAST ANGLIA.

IN the GEOLOGICAL MAGAZINE for July attention was called to the 25th volume of the Monographs of the Palæontographical Society, issued for 1871, and to a Memoir on the Geology of East Anglia, accompanied by a Map, prepared by Mr. S. V. Wood, jun., and Mr. F. W. Harmer, which formed an introduction to the first part of the Supplement to the Crag Mollusca by Mr. Wood, sen.

This memoir deserves a more special notice on account of the coloured geological map, which is by far the most elaborate one ever published on this area.

All of our readers may not be aware of the immense amount of labour and time which Mr. Wood and his coadjutor Mr. Harmer have devoted to the working out and classification of the Drift deposits of the East of England. Not content with merely visiting the principal sections in the country, they have actually surveyed on the one-inch Ordnance map the greater part of the geology of Norfolk, Suffolk, and Essex, and often with a detail which equals in minuteness some of our most elaborate Government Survey Maps. The Geological maps of parts of Essex, and the memoir on the Glacial and Post-Glacial beds of the South and East of England, which a few years ago Mr. Wood deposited in the Library of the Geological Society of London, alone exhibit a vast amount of patient labour and field work, which not many amateur geologists have equalled. In early times, De la Beche and Logan did a large amount of private field-work in the West of England and South Wales, and more recently Mr. William Sanders published his large maps on the scale of four inches to one mile of the Bristol Coal-fields. Such detailed labours, demanding of necessity much uninteresting but necessary work, will be lasting monuments to the honour of its authors.

In 1865 Mr. Wood privately printed and circulated a little map of the Upper Tertiaries of the whole of the Eastern Counties, accompanied by an explanatory memoir, which showed the general extent of the Drift deposits. The present map takes in the country east of a line drawn between Holt in Norfolk and Ipswich, and it extends as far south as Walton-on-the-Naze. It thus takes in the whole of the Crag country which it is intended mainly to illustrate. It has been reduced from the Ordnance Survey maps to a scale of four miles to the inch, and is accompanied by twenty-one coloured horizontal sections and twenty-two vertical ones.

In the Memoir Messrs. Wood and Harmer give a general account of the structure of the Coralline Crag, the Red and Fluvio-marine or Norwich Crags, the Chillesford beds, the Lower, Middle, and Upper Glacial beds, Plateau gravel, and Post-glacial beds. The Bridlington Crag is noticed as being probably posterior in age to the great chalky or Upper Boulder-clay; and other deposits, not included in the area comprised in the map, in which shells are noticed in the 'Crag Mollusca,' as the beds at Kelsea Hill, Paull Cliff, March, and Hunstanton, and the Nar Brickearth, are noticed among the Post-glacial formations. H. B. W.

III.—ELEMENTARY GEOLOGY; A COURSE OF NINE LECTURES, SPECIALLY ADAPTED FOR THE USE OF SCHOOLS AND JUNIOR STUDENTS. By J. CLIFTON WARD, F.G.S. 8vo., pp. 282. (Trübner & Co., London, 1872.)

THE EARTH'S CRUST. A HANDY OUTLINE OF GEOLOGY. By DAVID PAGE. Sixth Edition. 8vo., pp. 98. (Blackwood & Sons, Edinburgh and London, 1872.)

FIFTY years ago Geology was the pursuit rather of the man of fortune than of the less favoured individual who had to struggle for existence. Then it was a science more particularly of travel than it is now; mineralogy was its constant companion, for palæontology was not very far advanced. Now the science has made such progress that few men can be masters of it as a whole. Railways have furnished a cheap and ready means to gain a personal knowledge of all our British rocks; and those who have no time for travel can aid the good cause by studying some of the many forms of life that inhabited this earth in bygone times. We cannot wonder that the science is a popular one; for it can be studied perhaps with less expense than most other sciences, and is probably as well adapted as any for training the mind to those habits of reasoning which, as Canon Kingsley has shown in his "Town Geology," are of so much advantage to every one.

Geology is now taught in our principal schools, and there is no lack of text-books, elementary and advanced, to assist in diffusing a knowledge of the science.

Mr. Ward is a member of the Geological Survey of England, and he gives us in a course of nine lectures a very good and readable *résumé* of the principal facts of geology. The physical geology and geography is all we could desire in such an elementary work; the palæontological portion, or that part which treats of the series of strata, with their organic remains, gives hardly sufficient information as a text-book for schools, and it is not always so clear and accurate as we could have desired. The illustrations might also be improved, although they are no doubt sufficiently useful as diagrams.

On the whole, we can recommend Mr. Ward's book as a good introduction to more advanced works, and also as furnishing a readable work for those who have only time or inclination to get at the general idea of the science. His chapter on practical geology d his remarks on geological mapping will be found useful features the volume.

Dr. David Page has been before us many years as a teacher, and has lately been appointed Professor of Geology in the College Physical Science at Newcastle-on-Tyne. This little Outline fulfils intention as a simple guide to a general knowledge of geology. he illustrations are good, and there is an absence of detail in the xt, in this as well as in the other work, which will, we hope, imulate the reader to inquire further into the varied and interting history of the Earth's Crust.

V.—NOTES ON THE POST-PLIOCENE GEOLOGY OF CANADA. By J. W. DAWSON, LL.D., F.R.S., F.G.S., Principal of McGill University, Montreal.[1]

SINCE 1855, Principal Dawson has carried on a continuous and elaborate investigation of the Drift Deposit in Canada, the sults of which have been given to the world from time to time rough the medium of the "Canadian Naturalist." In all these ears, during which so much light has been thrown from almost ery side on Glacial theories, Dr. Dawson has seen no cause abandon his early conclusions on the subject, and his later servations have only strengthened him in his opinions. It is t surprising therefore that, his thoughts having ripened into nvictions, he should now wish to bring together the numerous cts which have led him to consider as indisputable his explanation the glaciation of the North American continent. This he has done the important memoir before us, which is a storehouse of materials t to be passed over by glacialists of every denomination, whether nd, marine, or a combination of both.

There is no mistaking Dr. Dawson's colours; he is a staunch arine glacialist, who fears not to speak lightly of the "glacier eory of Agassiz and others," which, according to him, "may be id to have grown, till, like the imaginary glaciers themselves, it erspread the earth." He smiles at the great ice-mantle imagined "stubborn land-glacialists," which "was even transferred to razil, and employed to excavate the valley of the Amazon. But is," he adds, "was its last feat, and it has recently been melting ay under the warmth of discussion, until it is now but a shadow its former self."

As we have before hinted in these pages, Dr. Dawson differs conlerably from Dr. Newberry in his interpretation of the glacial enomena of North America. The views of both these authorities ill be best understood perhaps if we reproduce the excellent little ble given by Dr. Dawson (see page 40):

It will be seen that Dr. Dawson regards the Erie Clay (although void of fossils) as the equivalent of the Boulder-clay and of the da Clay of Canada.

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[1] Reprinted from the "Canadian Naturalist," new series, vol. vi., Montreal, 1872.

TABULAR VIEWS OF GLACIAL DEPOSITS AND THEORIES.

INLAND PLAINS.	MARGINAL AREAS.	GLACIER THEORIES.	FLOATING ICE THEORIES.
Terraces.	Terraces and raised beaches.	Emergences of Modern Land.	
Travelled boulders and glaciated stones and rocks. Stratified sand and gravel. (Algoma sand, etc.)	Sand and gravel, with sea shells and boulders. (Saxicava sand.)	Shallow Seas and Floating Ice.	
Stratified clay with drift wood, and a few stones and boulders. (Erie clay.)	Stratified clay, with sea shells. (Leda clay.)	Deep water with Floating ice.	
	Clay and boulders with or without sea shells. (Boulder-clay.)	Submergence of the land.	Much floating ice and local glaciers.
Striated rocks.	Striated rocks.	Great continental mantle of ice.	Submergence of Pliocene land.
Old channels, indicating a higher level of the land.	Old channels indicating previous dry land.	Erosion by continental glaciers.	Erosion by atmospheric agencies, and accumulation of decomposed rock.

The Boulder-clay corresponds precisely in character with that of Scotland and Northern Europe; but land-ice has, in Dr. Dawson's opinion, had nothing to do with its formation. To the period of its deposition he assigns the excavation of the basins of the great American lakes. Of course he rejects utterly the possibility of the mode of this excavation being referred to glaciers. "Its real cause," he says, "was obviously the flowing of cold currents over the American land during its submergence." Further on he asserts that "running water could not have done this [cut out the lake-basins], for it could have no outlet," whereas in the same page (p. 14) he mentions with approval the large collection of facts given by Dr. Newberry in his Report on the Geology of Ohio, "which," he admits, "go far to show that were the old channels cleared of drift, and the continent slightly elevated, the great lakes would be drained into each other and into the ocean by the valleys of the Hudson and the Mississippi without any rock cutting." We do not know how Dr. Dawson reconciles the two statements.

The action of glaciers in Eastern America Dr. Dawson would limit to the most insignificant degree, and he indeed goes so far as to say that in Canada and Nova Scotia he has "seen nothing that could fairly be regarded as the work of glaciers." The moraines which less strictly marine glacialists often find in those regions, he regards as "shingle beaches and bars, old coastlines loaded with boulders and ozars" (*sic*).

ılthough Dr. Dawson states that the *coup de grâce* has been given he American continental glacier theory,—and that too by excess seal in its advocacy on the part of Prof. Dana!—yet we cannot ık that old sea-beaches can ever, in a majority of cases at least, mistaken for moraine-heaps by any tolerably keen-eyed field-logist.

'he great value of Principal Dawson's paper is however by no ıns lessened by its strongly controversial character; and the large)unt of clearly recorded facts which it contains must earn for high position as a work of reference concerning the regions of .ch it more especially treats.

'he palæontological part of the Memoir is very full, but is not wn up so as to be easily consulted for stratigraphical purposes.)ut 205 species are enumerated, all of which, with the exception :hree or four, are recent northern or arctic forms. Of these 16 y appear to belong to the Saxicava sand, including five land and h-water shells, which "seem to have been drifted by some fresh-er stream into the sea of the Saxicava sand and Leda clay." ır of the marine species have not been found below the Saxicava 1, but the rest are common to it and to the Leda clay. The ıt mass of the fossils is found immediately below the Saxicava d in the upper layers of the Leda clay, the main portions of both osits being comparatively barren. A new shell from the Leda ' is described in the paper before us under the name of *Choristes ans;* this is indeed the only new species found apparently in ʂe beds. Among the Foraminifera we notice the occurrence of a resentative of the genus *Saccammina*, a genus first dredged up Sars, who named it, which was next found fossil in a bed of ıestone of Lower Carboniferous age in Northumberland, and de-bed (*S. Carteri*) by Mr. H. B. Brady, and which it is interesting ınd turning up again unexpectedly (apparently in a stunted form) ;lacial beds on the other side of the Atlantic.

'he fauna of the Boulder-clay, on which Dr. Dawson must essarily rely to a great extent in pronouncing it to be of marine ;in, is very restricted, consisting (so far as we can make out from tudy of the lists given) of only seven species, all except one ımon to both Boulder and Leda clay. The localities in which the ılder-clay is fossiliferous are all, it seems, situated near and about mouth of the St. Lawrence, being quite barren of fossils further This appears to us to be a point of some importance scarcely ɜlt upon sufficiently by our author.

n conclusion, we cannot do better than let Dr. Dawson give, in own words, a summary of his views on the character and ıence of the phenomena connected with the glaciation of Canada:

In the earlier part of the (Glacial) period, the elevated land of Pliocene epoch gradually sank under the waters, and the remainder t became refrigerated and covered with snow and ice. At the od of greatest subsidence, nearly all the hills were submerged, heavy ice from the north ground over their summits; while the er part of the Boulder-clay and the lower beds of the Leda clay were deposited in the valleys. As the land rose again, ice-clad hills returned, and new though perhaps less extensive glaciers were formed, and fresh crops of boulders were deposited in the shallowing seas of the Saxicava period. Snow still exists throughout the summer in the higher ravines of the White Mountains, and on the hills of Labrador, and a subsidence of a few hundred feet in the valley of the St. Lawrence and the country to the southward, would suffice to restore them to the condition of snow-clad hills giving off icebergs from their bases, so near are we yet to the Glacial Period; and so little did it really differ from that condition of the continent which still exists."

13th December, 1872. G. A. L.

REPORTS AND PROCEEDINGS.

Geological Society of London.—I.—Nov. 20, 1872.—Prof. P. Martin Duncan, F.R.S., V.P., in the Chair.—The following communications were read:—1. "On the Geology of Thunder-Bay and Shabendowan Mining Districts on the North Shore of Lake Superior." By H. Alleyne Nicholson, M.D., F.G.S., etc.

The author described the general characters of Thunder Bay, which is almost landlocked on the south-east by the bold promontory of Thunder Cape and a series of islands which form a continuation of it. The rocks immediately surrounding Thunder Bay belong to the "Lower and Upper Copper-bearing series" of Canadian geologists. The latter, consisting of sandstones, shales, limestones, marls, and conglomerates, chiefly of a red or reddish colour, with interstratified traps, is regarded by the author as probably of Lower Silurian age, in accordance with the opinion of Sir Wm. Logan. The "Lower Copper-bearing series" is also very varied in character; it is traversed by trap-dykes, and contains several well-marked interstratified traps. It is penetrated by two sets of mineral veins, containing great abundance of silver. The majority of these run along the strike of the beds in a general E.N.E. and W.S.W. direction; the remainder are transverse, running nearly N. and S. Of the latter the most important is the "Silver-islet vein," which is three or four feet in width, and consists of quartz with native silver and galena; picked specimens of the stuff have assayed from £1000 to £2000 per ton. This vein has been worked for about two years, and has proved remarkably productive. Of the former series the most important is the "Shuniah vein," which runs along at a distance of one and a half to two miles from the north shore of Thunder Bay, the mines in which, although quite in their infancy, promise excellent results. Its width is twenty-two feet, and the vein-stuff consists mainly of calc-spar. The silver is present in the native form, and as sulphide. The vein traverses hard black shales, but does not run exactly along the strike of the beds; it may be traced for several miles towards the east.

The country between Thunder Bay and Lake Shabendowan, along the "Dawson Road," is of an undulating character, and the surface of its fundamental rocks everywhere exhibits unmistakable evidences of glaciation, the general direction of the striæ being N. and S., but with the occasional occurrence of a minor set of grooves running nearly E. and W. The greater part of the country is thickly covered with drift, composed of rocks which appear to have travelled from north to south.

The rocks passed over between Thunder Bay and Lake Shabendowan are described by the author as, 1, the shales and traps of the "Lower Copper-bearing series"; 2, a range of syenitic and gneissic rocks, probably of Laurentian age; 3, a great series of rocks belonging to the Huronian group, consisting of greenish or grey slates, with bands of gneiss and trap-dykes, and bedded green traps with great masses of greenish, grey, or drab-coloured slates, the whole presenting a close resemblance to the green slates and porphyries of the English Lake-district. The slates, in the author's opinion, are bedded felspathic ashes.

The author described the general characters of Lake Shabendowan, and stated that from the foot of the lake for about fifteen miles westward there is a succession of trappean rocks, beyond which, to the head of the lake, distant thirteen miles, the country is occupied by Huronian slates like those between the lake and Thunder Bay. These slates extend for an unknown distance north-west of the head of the lake, and contain numerous veins, having an E.N.E. and W.S.W. direction, conformable with the strike of the beds, and some of them are auriferous. The vein-stuff is quartz, containing copper pyrites; the gold is contained in the copper pyrites, or disseminated in very minute grains through the quartz. Several of these veins are being worked, and their peculiarities were noticed by the author.

Discussion.—Mr. H. Woodward mentioned that Dr. Nicholson had presented to the British Museum some of the rich specimens of silver ore described in the paper.

Mr. D. Forbes corroborated the author as to the richness of the ore. A lump which had been submitted to him, weighing 295 lbs., containing no less than 187 lbs. of silver. He called attention to the resemblance between the vein-stuff from Thunder Bay and that from the Konigsberg silver mines of Norway, many specimens being so much alike that it was impossible to distinguish them.

2. "Note on the Relations of the supposed Carboniferous Plants of Bear Island with the Palæozoic Flora of North America." By J. W. Dawson, LL.D., F.R.S., F.G.S., F.Z.S.

The author referred to Dr. Heer's paper on the Carboniferous Flora of Bear Island (see Q. J. G. S., vol. xxviii., p. 161), and stated that the plants cited by Dr. Heer as characteristic of his "Ursa Stage," are in part representatives of the American flora belonging to what the author has called the "Lower Carboniferous Coal-measures" (Subcarboniferous of Dana). He considered that the presence of Devonian forms was due either to the mixture of fossils from two distinct but contiguous beds, or to the fact that in these high northern latitudes there was an actual intermixture of the two floras. He dissented altogether from Dr. Heer's identification of these plants with those of the Chemung group, or with those of the Middle Devonian of New Brunswick.

Discussion.—Mr. Carruthers stated that the list of the eleven Lower Carboniferous plants published in Principal Dawson's "Acadian Geology" did not contain a single species found in Bear Island; but, on the other hand, some species and several well-marked forms were common to the Bear-Island deposits and the Devonians of North America, and he had no doubt that Prof. Heer had in his paper rightly correlated these floras. As to the age of these plant-bearing beds, found alike in Bear Island, Ireland, the Vosges Mountains, Canada, and Australia, Mr. Carruthers said that it was difficult to draw any lines which would separate the Palæozoic plants into clearly marked and distinct floras; but if the Devonian is to be retained as a system, all these plant-bearing beds belonged rather to that system than to the Carboniferous.

3. "Further Notes on Eocene Crustacea from Portsmouth." By Henry Woodward, Esq., F.G.S., F.Z.S.

In this paper, after referring to his former communication on Crustacea from the Lower Eocene deposits at Portsmouth (Q.J.G.S., vol. xxviii., p. 90), the author gave a full description of *Rhachiosoma bispinosa*, one of the new species described in it, the materials being furnished by several fresh specimens, which show the whole structure of the animal. The new points include the description of the limbs, the anterior border of the carapace, the lower surface of the body in both sexes, and the maxillipeds.

The author also characterized, under the name of *Litoricola*, a new genus of Shore-crabs allied to *Grapsus*, from the same deposits. Of this genus he described two new species, *L. glabra* and *L. dentata*.

Discussion.—Mr. Meyer gave some particulars as to the horizon from which these fossils were derived. They all came from the argillaceous sands with *Dentalium*, mentioned in his former paper. These beds are much mottled, probably owing to the burrowing of the crabs (*Palæocorystes*).

Mr. Woodward, in answer to inquiries, pointed out that these crustaceans were of purely littoral, and not of pelagic forms; and their feet were in a condition better adapted for walking than for swimming. The long epibranchial spines in *Rhachiosoma* formed weapons of offence, and were of much service to the pelagic forms, though their retention in the littoral forms was not of easy explanation. The *Litoricolæ* were essentially adapted for running on land and burrowing. As an instance of the disparity in the hands of crabs, he cited the common Calling crab, which had always one hand greatly larger than the other.

4. "On a new Trilobite from the Cape of Good Hope." By Henry Woodward, Esq., F.G.S.

The Trilobite described was obtained by Dr. W. G. Atherstone, F.G.S., from the Cock's Comb Mountains at the Cape of Good Hope, and was preserved in a nodule, the impression retained in which, when broken, furnished the most instructive details as to its structure. Each of the eleven thoracic segments was furnished with a long median dorsal spine, giving to the profile of the animal a crested appearance; on each side of this the axis of the segment bears two or three tubercles, and the ridge of the pleuræ four or five tubercles. The tail is terminated by a spine more than half an inch in length, and all the spines are annulated. For this Trilobite the author proposed the name of *Encrinurus cristagalli*, although with some doubt as to the genus, the head being only imperfectly preserved.

Discussion.—Mr. Evans called attention to the importance of examining the matrix out of which fossil Trilobites were extracted, as were it not for the matrix the spines on this specimen would have escaped observation.

Mr. Woodward had not until the day of the meeting been able to examine the Trilobites collected at the Cape by the late Mr. Bain, and had at first sight doubted whether the fossil he had described might not be identical with *Typhloniscus Bainii* of Salter; but on closer examination he was inclined to consider it distinct. He preferred for the present retaining it in the genus *Encrinurus*, but still with some doubt.

5. "On an Extensive Landslip at Glenorchy, Tasmania." By S. H. Wintle, Esq. Communicated by Professor Ramsay, F.R.S., V.P.G.S.

In this paper the author described the effects of an extensive landslip from the northern face of Mount Wellington, in Glenorchy, about five miles from Hobart Town. It took place during the night of the 4th June, 1872, after a rainfall of 4½ inches in twenty-four hours. The *débris* descended nearly 2000 feet into the bed of the rivulet of Glenorchy. By the force of the accompanying torrent great quantities of huge trees, some of them 200 feet long, were piled up in vast heaps, mixed with boulders, agricultural implements, fences, and other objects. The trees were deprived of bark, branches, and roots. The Carboniferous limestone forming the bed of the rivulet was exposed by the washing of the torrent for more than two miles; natural sections showed the blue, shelly limestone, alternating with beds of mudstone and shales. At one part the author found both banks of the rivulet lined with small, sharply angular fragments of dioritic greenstone from the summit of the mountain; large blocks of the same rock also occurred. The author described the beds displayed in a section close to the base of the great landslip, above which is a smooth surface of greenstone, covered with prostrate trees and immense blocks of greenstone half buried in yellow clay and sludge. The whole neighbourhood was described by the author as presenting evidences of former landslips. The author further described the appearances presented by the upper winding part of the gully traversed by the torrent; and, in conclusion, noticed certain results of similar phenomena as displayed in the same district. The paper was illustrated by three stereoscopic views.

Discussion.—Mr. W. T. Blanford mentioned somewhat similar landslips as occurring in the Himalayas, and on fully as extensive a scale. In some cases not only the loose soil but large masses of solid rock were carried down.

Mr. Drew mentioned other instances in India of a similar character, but thought that in the Himalayas frost also assisted in the work of destruction.

II.—December 4, 1872.—Prof. P. Martin Duncan, F.R.S., Vice-President, in the Chair.—The following communications were read:—

1. "On the Tremadoc Rocks in the Neighbourhood of St. David's, South Wales." By Henry Hicks, Esq., F.G.S.

The author stated that Tremadoc rocks occur in three distinct places near St. David's, namely in Ramsey Island, at the north end of Whitesand Bay, and over a considerable tract of country about five miles east of St. David's. They rest conformably on the Lingula-flags, and are about 1000 feet thick in Ramsey Island. The author noticed the fossils found in these deposits, nearly all of which are of new species, and stated that the palæontological evidence proves these rocks to be nearly allied to, if not identical with, the lower part of the Tremadoc rocks of North Wales. The Upper Tremadoc rocks of North Wales seem to be represented at St. David's by the so-called Arenig rocks which overlie the deposits described in the present paper.

The new species described by the author are as follows:—

Neseuretus (g. n. Trilob.) *Ramseyensis*, *quadratus*, *recurvatus*, and *elongatus*.
Niobe Menapiæ and *solvensis*.
Theca Davidii.

Bellerophon Ramseyensis and *solvensis*.
Palasterina Ramseyensis.
Dendrocrinus Cambrensis.
Ctenodonta Menapiensis and *Cambrensis*.
Palæarca Hopkinsoni and *oboloidea*.
Glyptarca (g. n.) *primæva* and *Lobleyi*.
Davidia (g. n.) *ornata* and *plana*.
Modiolopsis Ramseyensis, *Homfrayi*, *solvensis*, and *Cambrensis*.

He also noticed the occurrence in the deposit of *Lingulella Davisii*, M'Coy, *Lingula petalon*, Hicks, *Obolella plicata*, Hicks, *Orthis Carausii*, Salt., and *Menapia*, Hicks, and *Eophyton explanatus*, Hicks.

Discussion.—Mr. Lobley commented on the importance of the discovery of so many well-marked species of Lamellibranchiata in beds of an earlier date than those in which their presence had previously been known.

Mr. H. Woodward agreed in regarding the *Neseuretus* and other fossils exhibited by the author as new.

Mr. Hopkinson remarked on the similarity of the faunas of the Tremadoc and Arenig rocks to those of the Potsdam and Quebec rocks of America. With regard to the connexion between the Arenig and Llandeilo beds, he mentioned that but one or two species of Graptolites passed from one to the other. It was, however, between the Tremadoc and Arenig rocks, if anywhere, that there appeared to be a distinct break in the series.

2. "On the Phosphatic Nodules of the Cretaceous Rock of Cambridgeshire." By the Rev. O. Fisher, M.A., F.G.S.

The author stated that this paper was founded upon one read by him before the Society in May last, but subsequently withdrawn, in consequence of his obtaining information which necessitated a change of opinion upon certain points. The new portion related chiefly to those nodules which had been regarded as belonging to *Porospongia* or *Scyphia*, the fenestrated structure shown in sections of which the author now identified with the structure of *Ventriculites*, as described by Mr. Toulmin Smith, the whole arrangement, and especially the presence of an octahedral figure at the nodes where the fibres of the framework intersect one another, being in favour of this determination. The author described the peculiarities of these octahedra, and dwelt particularly upon the fact that these sections of phosphatic nodules showed clearly that the fibres are really tubular, and not, as Toulmin Smith supposed, solid.

3. "On the Ventriculitidæ of the Cambridge Upper Greensand." By W. Johnson Sollas, Esq., Associate of the Royal School of Mines, London. Communicated by the Rev. T. G. Bonney, M.A., F.G.S.

A collection of supposed sponges found in the Cambridge Upper Greensand had been in part referred to the genera *Scyphia* and *Porospongia*, and in part left unidentified. An examination of sections of these forms by the microscope had revealed all the details of Ventriculite structure; and a careful comparison with Mr. Toulmin Smith's descriptions and specimens had resulted in the identification of those examined with some four of Mr. Smith's species; thus *Scyphia tessellata* was shown to be equivalent to *Ventriculites tessellatus* (or, more correctly, *V. texturatus*), *Porospongia ocellata* to *V. cavatus*, and other unnamed forms to *V. quincuncialis* and *V. mammillaris* respectively. The occurrence of ventriculite-structure in coprolitic material presents a favourable opportunity for a fresh inquiry into its nature; accordingly the author described the minute characters of the hexradiate elements of which the skeleton is composed, and the combinations of these hexradiates with one another. Abnormalities occur sometimes by the hexradiates becoming heptoradiate or pentaradiate, and sometimes by some of their rays bending quite away from their normal course. The whole of the skeleton fibre is distinctly tubular. Since the Ventriculite fibres have now been found fossilized in chalk, flint, and calcic phosphate, there can be little doubt that they were keratose, and not siliceous in their nature. If this be so, we have a difference between Vitrea and Ventriculitidæ of ordinal value at least, and we must look for allies to the Ventriculites among the horny sponges. *Verongia* resembles Ventriculites in the single hollow cavity of its fibre and the non-spiculate character of its skeleton; *Darwinella* offers a resemblance in its hexradiate horny spicules, and *Spongionella* in the regular arrangement of its fibres. These three genera are indices of the directions in which the Keratosa tended to vary. At a very early period great variation occurred among the Keratosa, which already, at the time of the Weisse Jura, had evolved such highly symmetrical specialized forms as the Ventriculites; these, with their contemporary variations, such as Verongicid forms, lived on in great numbers throughout the Mesozoic period, with the close of which the Ventriculites altogether disappeared; and the nearest allies dwindled down to the dwarfed and rare genera *Verongia*, *Darwinella*, and perhaps *Spongionella*.

Discussion.—Mr. J. F. Walker was not prepared to admit that all phosphatic nodules had been organized bodies, inasmuch as most of the fossil shells in the deposit were found filled with phosphatic mud of the same nature as the nodules.

Mr. Charlesworth also disputed the organic origin of the amorphous coprolites, and pointed out the analogies between the so-called coprolites of the Crag and those of the Upper Greensand, and the flints of the Chalk. He cited Ehrenberg as of opinion that the latter were masses of fossilized Infusoria, while Dr. Bowerbank maintained that they were merely fossil sponges, and drew the deduction that caution was necessary in accepting any theory as to the origin of the phosphatic nodules.

Mr. Seeley was not entirely in accord with Mr. Fisher as to the number of forms assumed by the phosphatic nodules. There were some that resembled common septaria, and in many cases the original form, especially in the case of the presumed ventriculites, had been much modified by rolling on the sea-bottom. In support of the view of the sponge-origin of some of the nodules, he exhibited some of the modern forms of sponges enveloping different objects in the same manner as the phosphatic matter included in shells and other fossils. The *Porospongiæ* in the Woodwardian Museum were, he said, not phosphatic, but calcareous fossils; and he thought there had been some mistake by Mr. Sollas in alluding to these specimens. The phosphatic masses were frequently drilled and filled with glauconite and other matter. He doubted the ventriculite origin of many of the nodules, and pointed out that the so-called ventriculites were in reality *Ocellariæ*.

Mr. H. Woodward mentioned that a similar structure to that described in the Ventriculites had been observed by his colleague Mr. Kent in a modern siliceous sponge, and observed on the similarity in some respects between ventriculite-structure and that of *Euplectella aspergillum*. He thought that, whatever might be the origin of some of the Chalk-flints and phosphatic nodules, it was quite impossible to refer the whole of them to the growth of sponges.

Mr. Fisher, in reply, did not agree with some of the speakers in considering that various organic remains were often found imbedded in coprolitic matter, though many were filled or partially covered with it. There was, he thought, a difference between the coprolites of the Crag and those of the Greensand; the surface of the great bulk of the latter had to his eye an unmistakably organic appearance. In some cases he thought they might have been allied to *Alcyonaria*. He did not agree with Mr. Seeley as to many of them being in a rolled condition.

Mr. Sollas stated that some of the coprolites contained siliceous *Xanthidia* and *Polycystina* uninjured, which afforded an argument against regarding the Ventriculites as having originally had a siliceous skeleton, which had subsequently been replaced by phosphate of lime. He had also found well-preserved siliceous spicules in the coprolites. The forms, though numerous, were well defined and susceptible of classification, which he had attempted to undertake. He could not acknowledge any mistake in *reference* to *Porospongia*.

GEOLOGISTS' ASSOCIATION.—December 6th.—The Rev. Thos. Wiltshire, M.A., F.G.S., in the Chair.

1. "On Coal Seams in the Permian at Ifton, Shropshire, with Remarks on the supposed Glacial Climate of the Permian Period." By D. C. Davies, F.G.S. The author showed the existence of three well-defined and workable seams of coal *above* the red sandstones and marls which are generally held to form the base of the Permian strata. He then proceeded to show the identity of these red beds with similar beds overlying the Coal throughout several of the Midland Counties, and with the red sandstones of the north of England, and also that the overlying sandstones, shales, and coals were the equivalents of the magnesian limestones and calcareous conglomerates which occupy the same horizon in widely distant places. After referring to the former probable extension of these beds over a large area, the author pointed out that in the neighbourhood described the gap or break, which is usually supposed to occur between the Coal-measures and the Permian, was partly, if not quite, bridged over. He also noticed how the different geological formations were dovetailed into each other, the old passing into the new, and not divided by

sharp, well-defined lines. From the identity of the age of these Coal-seams with the Permian conglomerate of Alberbury, only fifteen miles distant, he questioned the probability of that conglomerate being of glacial origin, since two climates so dissimilar as a glacial one and that in which a Carboniferous flora flourished could not exist together within so limited an area. In conclusion, Mr. Davies pointed out the necessity for alterations of the boundaries of the Permian and the Coal-measures in any future geological maps of the district.

2. "Note on a Well-Section at Finchley." By Caleb Evans, F.G.S. The author described the various strata traversed by a well recently sunk by the East Barnet Gas and Water Company at the north end of Finchley. The strata are as follows: glacial clays, gravels, and sands, 55 feet; London clay (with basement bed containing *Cyprina*, *Panopæa*, etc.), 171 feet; Lower Tertiaries (mottled clay, pebble beds, and sand), 58 feet; chalk with flints, about 216 feet. At this depth a good supply of water has been obtained.

CORRESPONDENCE.

THE GEOLOGICAL SURVEY IN THE SOUTH OF SCOTLAND.

Sir,—In reply to Mr. Jack's letter in the December number of the Geological Magazine, I beg to refer him to Mr. Lapworth's communication in the same number, from which it will be seen that an opinion, practically identical with the one I expressed in the previous number, has for some time been held by Mr. Lapworth, who has thoroughly and completely worked out the inter-relations of the Moffat shales, and from whom I received the first hint that these shales were capable of division, by their fossils, into distinct zones, easily recognizable in localities far apart.

Pending the issue of the Geological Survey Memoir on the whole Silurian region of the South of Scotland, in which, I infer, from Mr. Jack's letter, the fossiliferous rocks will be distinguished bed by bed, and all the fossils assigned to their proper zones, I adhere to the conclusion at which I arrived about two years ago, after examining a series of fossils collected by the Geological Survey of Scotland in the Leadhills district, and which is expressed in the Annals of Natural History for May, 1871, viz. that these fossils "parallel the rocks of this locality [Leadhills] with those of Moffat, Dumfriesshire, or with the Llandeilo flags of Wales.

Mr. Lapworth may perhaps be right in referring some of the higher zones of this Graptolite-bearing shale (which have only come under my observation in the Moffat district) to a higher horizon than the Llandeilo, for they are characterized by the presence of several species which occur in the overlying Gala group, in its representative, the "Graptolitic-mudstone" of Westmoreland, and in Barrande's *étage E.* in Bohemia, while they have not yet been found in the Llandeilo rocks in Wales. Whether, however, a series, away from the Welsh area, should be referred to the summit of the Llandeilo or to the base of the Bala group, is a matter, at present, of no great moment. I refer to it here to show that, in describing my new species of Graptolites as "Graptolites of the Moffat Group," I was not unaware that a division of the beds in which they occur might be possible after a careful survey of the whole region; but, while fully acknowledging the admirable manner in which Mr. Jack has mapped and described those portions of the Silurian region of the South of Scotland which *he has him*self examined, I cannot concur in his opinion that the Leadhills shale is many thousand feet higher, and therefore of much younger geological age, than that of Moffat.

JOHN HOPKINSON.

BIOGRAPHICAL INQUIRIES.

SIR,—The difficulty I found in getting together information about Richardson, Townsend, and Lonsdale,[1] and the scantiness of the records of many other of the early geologists, has led me to wish that we had a recognized channel for Notes and Queries on subjects of geological history.

I venture to submit that a page or two of the GEOLOGICAL MAGAZINE given to this purpose would be welcomed by young geologists. There are many of the older Fellows of the Geological Society who cherish in their memories fragmentary reminiscences of some of the most honoured and useful among the early workers in the science and the founders of the Society. Some of these preserved, even as detached records, would be of value.

The method of working, opinions held, but never printed, journeys taken, acquaintance with other scientific men, are facts about geologists which may often explain the meaning of their writings.

The origin of many of our geological terms in use, the time and reason of the abandonment of old terms and classifications, the gradual growth and spread of opinions before any indication of them appears in print, are all matters on which young geologists can gain no information except they can be obtained from the veterans of the science and placed on permanent record in print.

A correct appreciation of what has been already done is the first step to future work. Though your MAGAZINE is devoted to the *advancement* of science, I beg your consideration as to whether such notes as I suggest may not fitly find a place.

New University Club, St. James's St.,
London, S.W., *December* 18, 1872.

W. S. M.

NOTES AND QUERIES.

1. Cuvier and Brongniart, in the first abstract they published of their work, state that they made a hurried communication before their investigations were complete because "some circumstances" compelled them to publish at once, in order to claim priority of date. Has it ever been openly stated what these circumstances were? Had they anything to do with William Smith's work in England?

2. In Hamilton's Anniversary Address to the Geological Society on February 15th, 1856, in the obituary notice of Greenough, is this passage, "In that year (1807) he succeeded in associating with himself several active and able advocates of the then infant science, the result of which was a proposal to found a new society, for the furtherance of geological and mineralogical sciences. A printed list of geological queries was issued, and regulations for the management of a new society were discussed and arranged."

Is there any copy of this printed list in existence? It would be interesting to know what were considered at that time to be important geological queries.

W. S. M.

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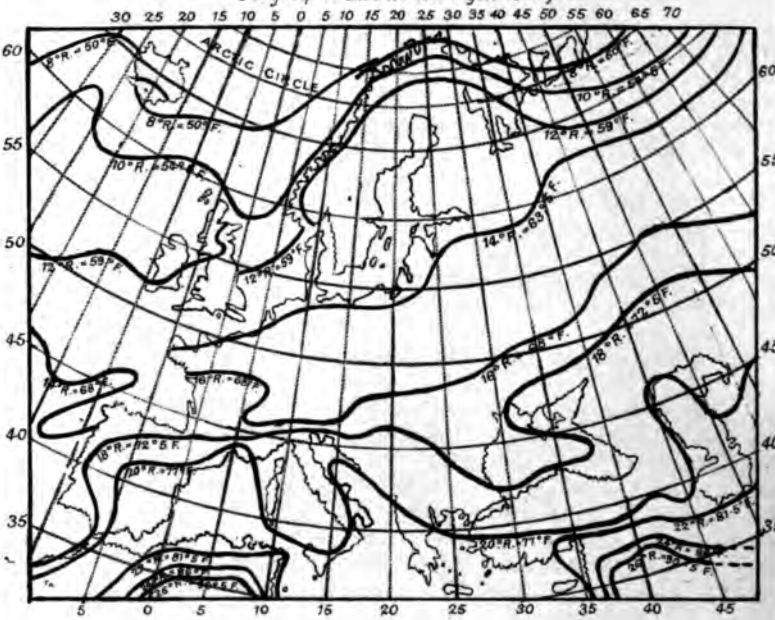
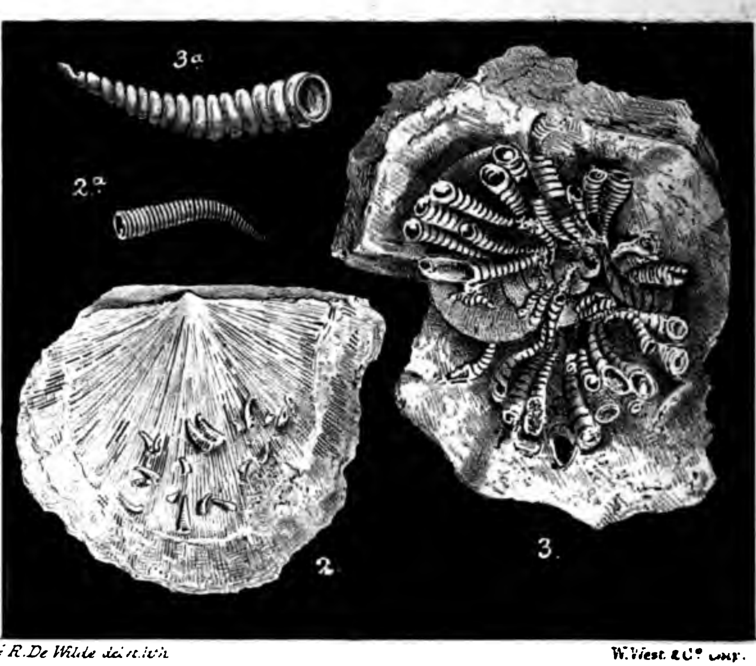
[1] See Proceedings, Bath Field Nat. Club, 1872.

MAP OF EUROPE WITH ISOTHERMAL LINES OF JULY.
(Reduced from Dr. A. Petermann's Memoir on the Gulf-stream: Geographische Mittheilungen 1870.)





G. R. De Wilde del. et lith. W. West & Co. imp.

Fig. 1. — To illustrate Mr. Geikie's paper.
Fig. 2 & 3. To illustrate Prof. H. Alleyne Nicholson's paper.

THE
GEOLOGICAL MAGAZINE.

No. CIV.—FEBRUARY, 1873.

ORIGINAL ARTICLES.

I.—On the Theory of Seasonal Migrations during the Pleistocene Period.

By James Geikie, F.R.S.E.,
District Surveyor, Geological Survey of Scotland.

(PLATE IV. Fig. 1.)

IN a paper recently read before the Geological Society,[1] Mr. Dawkins has re-stated his views concerning the climate of the Pleistocene period, and has replied to certain objections to his theory brought forward by myself in former numbers of this Magazine.[2] After carefully reading the paper referred to, I find no reason to alter or modify what I have written upon this question. Mr. Dawkins has unfortunately missed the point of my objections; and my argument, as it seems to me, remains unanswered. But as that gentleman has introduced some new matter into his own argument, I shall endeavour as briefly as may be to review his position.

In his former papers Mr. Dawkins contented himself with stating his opinion that the appearances presented by our river-gravels and cave-deposits were only explicable on the assumption that something like a Siberian climate had characterized Europe during Pleistocene times. He did not, however, tell us how such a climate was induced or could be induced under the physical conditions which are inferred to have obtained during the last continental state of the British area. He now informs us that the climate he postulates was brought about by "the extension of a large mass of land from the equator to the polar circle. Such a mass of land extended from the range of Atlas northwards to the snowy regions of Scandinavia during the Pleistocene age, the Mediterranean being reduced to two land-locked seas, and the mainland of Africa being continued on the one hand into Spain, and on the other, by Malta and Sicily, into Italy, and Greece extending so far south as to embrace Candia. Such an extent of land," he continues, "is surely an exact parallel to the two cases which I have quoted above (viz. North America and Northern Asia); and climatal extremes must necessarily have been the result of the substitution of land for such a large area that is now covered by the sea." This is a wonderful conclusion, and one which I feel quite sure no physicist will adopt. But I shall come to that presently. Meanwhile, geologists may well ask what are the grounds upon which they are invited to believe that during the period of local glaciers, when Britain formed part of the continent, the whole area of the Mediterranean stood some 3000 feet higher than at present? The only fact adduced in support of this hypothesis is simply this:—remains of *Hippopotamus Pentlandi* occur at Megalopolis in the Morea, and in Crete.

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[1] See Quart. Journ. Geol. Soc., 1872, vol. xxviii., p. 410.
[2] Geol. Mag. Vol. IX. pp. 164, 215.

But before this fact can become of any service whatever to the "migration" theory, it will be necessary to prove that the remains in question really belong to late Pleistocene times (*i.e.* our local glacier period). For aught any one can say, however, the Candian hippopotamus may date back to the early Pleistocene or even to the Pliocene. We know far too little as yet about the synchronism of later Tertiary deposits in different parts of Europe to justify us in at once fixing the precise age of the little hippopotamus. *Hippopotamus major* is believed to have lived in Europe during Pliocene times, and there is certainly no *a priori* reason why the smaller species should not have occupied the same area at approximately the same time. It *may* belong exclusively to late Pleistocene times, but at present the evidence does not entitle us to hazard this assumption.

Again, those who believe in the wonderful powers of locomotion ascribed to the Pleistocene pachyderms, may be excused if they should ask whether so great an elevation of the Mediterranean area as 500 fathoms, is really required by the circumstances of the case. Might not an active animal have swum across from Greece to Candia, by way of Cerigo, Cerigotto, and the little islets in their neighbourhood? The distance between Cerigotto and Candia is, to be sure, twenty miles; but that could hardly have been considered a barrier by the enterprising hippopotamus of Pleistocene times. If the voyage, however, should be thought rather too long, even for a Pleistocene wanderer, we might suppose it shortened by a much less elevation than 500 [1] fathoms—say 250 fathoms. With this amount of upheaval several islets would appear between Candia and Greece, to serve as baiting places, and the hippopotamus might then have performed its journey in easy stages, *per mare et terras*.

But we do not need to tax the swimming powers of the little hippopotamus in order to show that an elevation of the sea-bed to the extent of 500 fathoms is quite unnecessary to account for the presence of that pachyderm in Candia. An examination of the Admiralty Charts shows no greater depth than 210 fathoms between Candia, Kaxo, Karpathos, Rhodes, and the mainland of Asia Minor. The depth is even ten fathoms less than this, by way of Rhodes, Astropalia, Kos, and Kalimno. Thus by an elevation of only 200 fathoms Candia might, for aught we know,[2] become connected

[1] The greatest depth between Greece and Candia indicated upon the Admiralty Chart of the Mediterranean is only 300 fathoms. But the actual depth may be more, as the bottom was not reached by the sounding-line.

[2] It must be understood that the Admiralty soundings are not continuous between these islands any more than they are between Cape Malea (Morea) and Cape Spada (Candia).

with the mainland, and there is no reason why the hippopotamus may not have reached Candia by this route.

Finally, it is quite certain that even could we demonstrate that Candia was joined to the mainland in late Pleistocene times, still our demonstration would not prove that all the Mediterranean area stood at the same high level. Unequal movements have taken place contemporaneously within the Mediterranean basin, and it might quite well be, that the western regions of the Mediterranean stood at their present level or were even depressed below it at the very time that Candia formed part of the mainland. It seems to me, therefore, that the Candian hippopotamus is asked to prove too much, and that less questionable evidence must be adduced before we can be expected to believe that during our local glacier period the Mediterranean existed as two land-locked seas.

For the sake of argument, however, I shall admit that all the geographical changes desiderated did actually obtain. And yet, admitting this, I still hold that the climate required by the "migration" theory could not possibly result. We must remember that, in speculating upon the climate of so recent a period as the Pleistocene, we tread upon infinitely surer ground than when we are attempting to discover the conditions under which Silurian, Liassic, or even Miocene and Pliocene deposits were accumulated. At the beginning of Pleistocene times the physical features of our continent were much the same as they are now,—all the great high grounds, all the great drainage-systems, were even then in existence. Denudation, no doubt, helped during the Pleistocene age to modify these features; but, when viewed on the large scale, such modifications of the land's surface may be disregarded. Then, if this be so,—if the changes referred to were, comparatively speaking, so inconsiderable,—we may be very sure that since the disappearance of local glaciers in Britain there has been even less change in the physical features of Europe. This is one important fact to remember.

Again, we know that under the present condition of things, our continent owes the equableness of its climate in great measure to the influence of the Atlantic. This is another important fact that we cannot lose sight of, but which seems strangely enough to have escaped Mr. Dawkins' attention. Were an extensive land-surface to be substituted for that great ocean, there is no reason to doubt that our summers and winters would be as excessive as those in similar latitudes of Asia and North America.

A glance at the map of the world will show that in almost every particular the continent of Europe differs from those of Asia and North America. And as one result of this, the climates are essentially different also. Now the question to be considered is simply this: supposing that the British area were to become continental, and our shores to extend some little distance further into the Atlantic, the Mediterranean at the same time being reduced to two land-locked seas,—and supposing further that all the present glacier areas in Europe were to be considerably increased in size, perennial snow and ice filling the upland valleys of Great Britain and Ireland,

and those of other mountain districts in our continent which are now destitute of glaciers,—would all this result in producing a climate like that experienced in Northern Asia and the temperate latitudes of North America?

The immediate effect produced by the conversion of a large part of the Mediterranean into dry land would be something like the following. The hot dry winds coming from Africa would part with less warmth and suck up less moisture than they do now, and, as a consequence of this, summer in the countries bordering upon the Mediterranean would be hotter and drier. Mr. Dawkins seems to have a decided objection to winds. "All speculations as to the prevalent wind at that remote time in different parts of Europe appear to me," he says, "mere guesses, and nothing else." Perhaps he will tell us how otherwise than by winds the extra warmth derived from his hypothetical land was to be carried north. Either winds brought the warmth north, or they stole away with it in some other direction; but if central Europe was to have its climate influenced by the new-born land, then a southerly wind was the only medium by which such a result could have been effected.

Now we know that in the present economy of things the climatal influence of the Mediterranean in summer-time extends but a very short distance north into Europe. It certainly does not cross either the Alps or the Pyrenees. A line drawn from Bayonne by Viviers and Turin to the head of the Adriatic corresponds to the July isothermal line of 72°·5 F. When the same line is continued towards the north-east into Hungary, it suddenly sweeps down to Constantinople; and, circling round the Black Sea, returns upon itself at Odessa, after which it continues for some distance in the normal north-easterly direction. That sudden curve to the south-east is, of course, due to the presence of the Black Sea, and seeing that the Mediterranean does not influence the same isothermal line either in France, Italy, or Austria, it is quite clear that the modifying effect of this large inland sea has nothing whatever to do with the climate of central Europe. South of the line referred to, however, we find the July isotherms violently disturbed. That of 77° F. runs along the shores of the Mediterranean from Barcelona by Perpignan and Montpellier to Toulon. From this place it strikes directly S.S.E. to Cape Spartivento, then curves gently on to Palermo, after which it sweeps round by Messina and the Gulf of Taranto, across Italy, and more than half-way up the Adriatic. It then doubles suddenly back upon itself, skirts the eastern shores of the Adriatic, and crosses the south of Turkey and the Ægean Sea to Mytelene and Asia Minor. This irregularity is just as surely caused by the presence of the Mediterranean as the abrupt curving of the July isothermal line of 72°·5 is due to that of the Black Sea. In short, it is perfectly apparent that the isotheral lines in the south of Europe are deflected by the inland seas from their normal direction,—this deflection being confined to the immediate proximity of these basins. But in central and northern Europe all the isotheral lines are pushed south by the *overwhelming* influence of the Atlantic (see Chart Plate IV. Fig. 1);

while, in the opposite season, all the isocheimal lines are swept boldly north and north-east.

Were the Mediterranean to be converted into two land-locked seas, the isotheral lines in that area would then be less disturbed, and would preserve the general south-west and north-east trend which they follow in central Europe. The summers in Italy, Turkey, and Greece would thus be somewhat hotter and drier, but the general summer temperature of Europe would remain unaffected. The winds flowing from the south would no doubt be warmer, but they would also carry less moisture. When they reached the Alps, they would part with their warmth and moisture, just as they do now; but since they would bring more of the one and less of the other than at present, the snow-fields and glaciers on the south side of the Alps would tend to shrink back. Again, the isothermal chart shows that the supposed increase of land would not produce any appreciable climatal effect beyond a short distance into Spain and France, while not a trace of its influence would reach England. The Continent, laved along its entire western borders by a wide ocean, would be cooled over an immense area by the winds blowing from west and south-west; such is the case now,[1] and it must have been equally so in late Pleistocene times. Nor can we forget that the presence of great snow-fields and glaciers in every mountain district would tend still more to keep down the summer temperature. Thus, even had the warmth derived from the Mediterranean area been ten times greater than we can conceive it to have been, its effect would, nevertheless, be counterbalanced, and far more than counterbalanced, by the influence of the Atlantic and the presence of the glaciers and snow-fields. Mr. Dawkins, however, thinks, that "the inference that the summer temperature would be lower than at present in Britain, because there were glacier-areas in the north and in the higher districts in Central Europe, is inconclusive, since the mere existence of a glacier tells us nothing of the summer heat of the surrounding regions. Could we predicate, for instance, the temperature of the Subhimalayas from the contemplation of the glaciers of the central ridge? or the summer heat of Lombardy or of Provence from the glaciers of the Alps?" I confess I do not see the force of these remarks. Britain is not in the latitude of northern India, neither is it in that of Lombardy; while, in comparison with the Alps and the Himalayas, our mountains are mere monticules. We are not discussing the climate of some hypothetical land in the planet Mars, but are treating of that of a well-defined region, the geographical and physical conditions of which during late Pleistocene times have been definitely enough determined. The causes that render the summers of Europe much less excessive than those of Asia and North America were assuredly in existence during the period referred to. We are perfectly justified, therefore, in holding that with snow-fields and glaciers in our area it is absolutely impossible that our summers could have been so warm as they are now. It would be a different matter indeed could we suppose the Atlantic to have been obliterated at the same time as the Mediterranean! But under such geographical and physical conditions as did actually obtain in north-western Europe during our local-glacier period, it is quite clear that the summers in Britain must have been miserably ungenial, and the vegetation poor and scanty. The Arctic sun, instead of shining as in Asia upon flat snowless plains, would strike its rays in the extreme north of Europe over extensive snow-fields, where all the heat would be taken up in melting the snow, and consequently any wind that reached our latitudes from the north would be cold and ungenial.

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[1] See Professor Coffin's elaborate memoir on the "Winds of the Northern Hemisphere," *Smithsonian Contributions*, 1853.

In winter-time, supposing the Gulf-stream to have flowed then as it flows now, the cold would be ameliorated over all western Europe. But should the presence of the Gulf-stream be objected to, then, in the absence of this great heat-bringer, our winters would indeed be excessive, and our summers dreary in the extreme. In short, we may conclude that so long as Europe exposes a vast line of coast to the Atlantic, and so long as her physical features endure, just so long will her climate continue to differ from that of either Asia or North America, no matter whether or not the British Islands become continental or the area of land in the Mediterranean basin be increased. And as it is in the present, so also it must have been in the past. No mere obliteration of our inland seas could neutralize the influence of the outlying ocean. If the summers of Europe are at present rendered less excessive by the presence of the Atlantic, the same must have been the case during the last continental condition of our islands, and that to a much greater degree, owing to the presence of more numerous and larger snow-fields. For this, if for no other reason, it seems to me that the theory of seasonal migrations during the Pleistocene period must be abandoned.

In illustration of Mr. Geikie's paper, see Pl. IV. Fig. 1. Map of Europe, with Isothermal lines of July, Reduced from Dr. A. Petermann's Memoir on the Gulf Stream, Geographische Mittheilungen, 1870.

II.—DESCRIPTIONS OF TWO NEW SPECIES OF FOSSIL TUBICOLAR ANNELIDES.

By H. ALLEYNE NICHOLSON, M.D., D.Sc., M.A., F.R.S.E.
Professor of Natural History and Botany in University College, Toronto.

(PLATE IV. FIGS. 2 AND 3.)

IN a recent paper (American Journal of Science and Arts, vol. iii., March, 1872), I founded a new genus, under the name of *Conchicolites*, for the reception of some singular Tubicolar Annelides found growing upon the shells of *Orthocerata* in the Lower Silurian of the North of England. The following were the characters which I ascribed to the genus, and to the single species upon which it was founded:

CONCHICOLITES, Nich.—Animal social, inhabiting a calcareous (?) tube, attached in clustered masses to some solid body. The tube conical, slightly curved, attached by its smaller extremity. The wall of the tube thin, its external surface devoid of longitudinal *striæ. The tube thin,* composed of short imbricated rings, but apparently destitute of any cellular structure. Cast of the tube composed of short conical rings, its surface completely smooth, and destitute of striæ or furrows.

Conchicolites gregarius, Nich.—Tubes closely in contact, attached by their smaller ends to dead shells. Tube varying in length from a quarter to half an inch, and having a diameter at its mouth of about half a line. Conical rings which compose the tube about four in the space of a line.

I have now to describe a very distinct and beautiful species of this genus, which has been forwarded to me through the kindness of Prof. Edward Orton, of the Geological Survey of Ohio, and for which I propose the name of *Conchicolites corrugatus*, from the strongly-marked annulations of the tube.

Conchicolites corrugatus, Nich.—Tubes growing socially in clustered masses upon the shells of molluscs; calcareous; destitute of vesicular structure; conical, and gently curved. Attached by their smaller extremities, sometimes for the space of a line or more; and either partially free, or contiguous to one another throughout the remainder of their course. Length of the fully-grown tube $\frac{1}{2}$ inch or a little more; diameter of tube at mouth $\frac{1}{10}$ inch. Tube composed of conical imbricating rings, about forty in the space of an inch (about four in the space of $\frac{1}{10}$ inch), giving the tube a strongly annulated appearance.

The exquisite preservation of the specimen from which the above description is taken (Plate IV. Fig. 2) enables me to settle definitely certain points connected with the structure of *Conchicolites*, about which my specimens of *C. gregarius* had left me in doubt. It is now certain, as I had previously conjectured, that the tubes in this genus agree with those of the modern *Serpulæ* in being calcareous, and that they differ altogether from the extinct genus *Cornulites* in being altogether destitute of any cellular structure. They differ from *Serpulæ* in having the tubes composed of a succession of imbricated rings, the wider ends of which are directed towards the mouth of the tube. From the extinct *Ortonia*, again, they differ, not only in the circumstance just mentioned, but in their social clustered habit of growth, and in the fact that the tube is not attached along the whole of one of its sides.

The specimen figured exhibits the tubes of more than thirty individuals of *Conchicolites corrugatus* attached to the spire of *Cyclonema bilix*, Conrad. The tubes are all attached to the shell by their smaller ends, and radiate from their points of attachment, somewhat like the spokes of a wheel. Each tube is conical, circular, or nearly so, in section, and widening out gradually from its apex to its mouth. When carefully examined, it can readily be made out that the tube really consists of a succession of short calcareous rings of a conical form, inserted one within the other—this structure being especially perceptible in the interior of the broken tubes. From the exterior, however, the appearance is more that of a succession of strongly marked ridges or annulations, which completely surround the tube, and are separated by slight depressions or flattened interspaces. None of the tubes are perfectly straight, but all are more or less curved, especially towards their attached ends. The extent of the attached portion of the tube varies, being mostly from one to two lines. Their unattached portions run generally (in any two contiguous tubes) more or less nearly parallel to one another; but, though in contact in many instances, it is doubtful if they are actually adherent, and they are most probably not so.

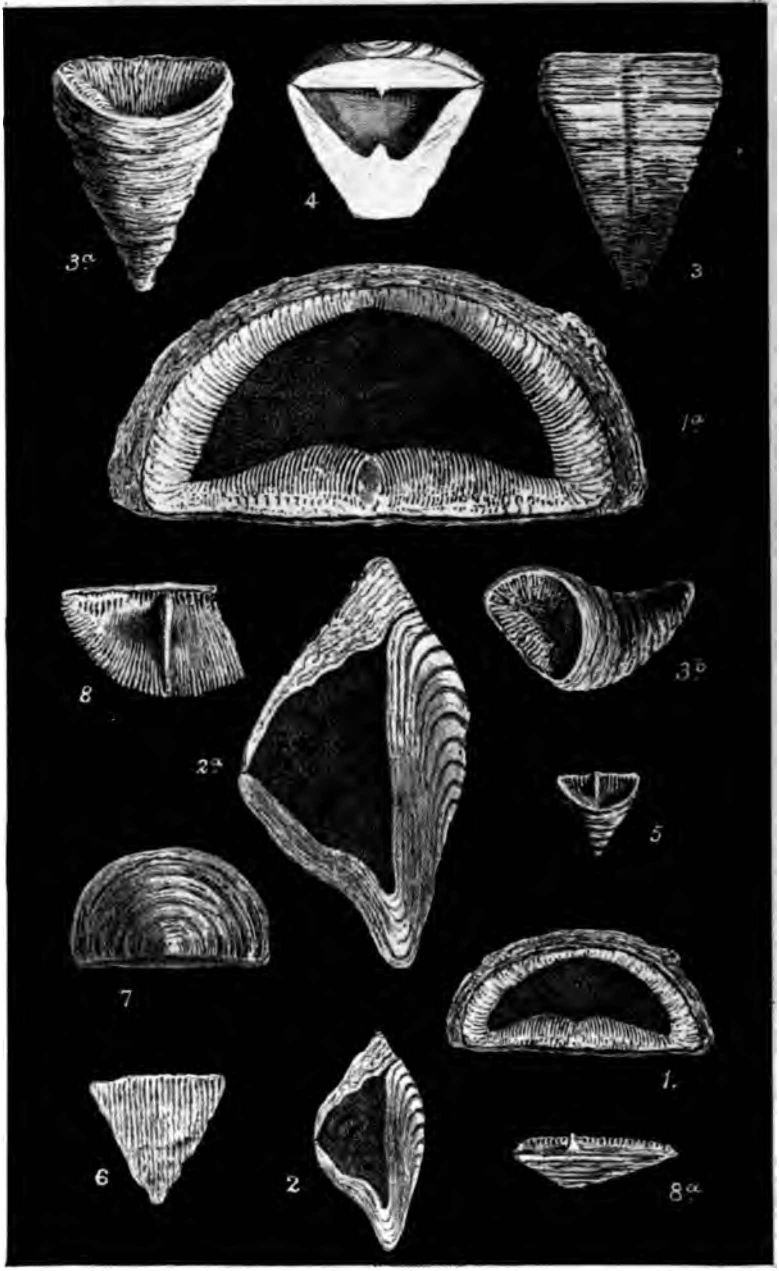
From *Conchicolites gregarius*, the present species is distinguished by its greater average length and much greater diameter, by its much less closely crowded habit, and by its much more strongly marked annulations.

Loc. and Form.—Attached to the shell of *Cyclonema* (*Pleurotomaria*) *bilix*, Conrad, from the Hudson River Group (Lower Silurian) of Cincinnati, Ohio.

Ortonia minor, Nich.—*Spec. Char.* Tube calcareous, solitary, attached by the whole of one side to some foreign object. Length of tube from $\frac{1}{10}$ to $\frac{3}{20}$ of an inch; diameter at mouth from $\frac{1}{20}$ to $\frac{1}{25}$ of an inch. Tube marked with transverse ridges or annulations, which are sometimes faintly marked on the side opposite to the attached surface, and the number of which is about fifteen in a tenth of an inch. Tube in general strongly curved towards its smaller extremity (Plate IV. Fig. 3).

Numerous specimens of this very distinct species have been placed in my hands by Professor Orton and Mr. U. P. James of Cincinnati. They occur growing upon valves of *Strophomena*, *Orthis planoconvexa*, Hall, and other Brachiopods; and I have also a fragment of *Chætetes lycoperdon*, Lay, covered with these little tubes. There can be no doubt as to the correct reference of this species to the genus *Ortonia*, which I recently proposed (GEOLOGICAL MAGAZINE, Vol. IX. p. 446) for another Tubicolar Annelide from the same horizon. The only point in which it does not agree with the character which I proposed for *Ortonia*, is that it does not appear to have any cellular structure of the tube. In *Ortonia conica*, however, this cellular structure is confined entirely to a small portion of the tube (namely, to that portion opposite to the attached surface), and the absence of even this in the present species shows that it cannot be regarded as a generic character. The only approach to the same structure which I can detect in *Ortonia minor* is that the transverse rings or annulations which surround the tube become faint or obsolete on the side opposite to the attached surface. Even this, however, is by no means constant, and the rings are sometimes completely continuous over the whole unattached surface of the tube.

Though often occurring in great numbers together, the tubes of *Ortonia minor*, like those of *Ortonia conica*, are strictly speaking solitary; that is to say, they do not, like the tubes of *Serpula* or *Conchicolites*, interfere with one another or come into contact except accidentally. The tube is generally pretty nearly circular in section, though sometimes slightly trigonal, conical, and always more or less curved. Sometimes it is simply curved like a horn; sometimes it is



G. R. De Wilde del. et lith.

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Calceola sandalina, Lamk, Devonian Eifel.

like the letter S; and sometimes the smaller extremity is into a flat spiral. I can detect no longitudinal striation, but e is covered with very numerous transverse ridges (at least the space of an inch), which are generally better marked on s than on the back of the tube. In very small, presumably specimens I have been unable to determine the existence e ridges, and even in fully-grown examples they are more y marked in some than in others. The tube is always attached ts whole length, and in no case is any portion free, as is the *Conchicolites.*

and Form.—Common in the Hudson River Group (Lower i) of Cincinnati, Ohio, attached to the exterior of Brachiopods rals.

nclusion, I may mention here some singular fossils from the ocality and formation as the preceding, which have been submitted to me by Mr. U. P. James, of Cincinnati, but the ture of which seems uncertain. The fossils in question were lly named by Mr. James *Tentaculites minuta* (MS.), and they ly present some resemblances to this genus. They consist of , conical, flexuous, or curved tubes, about $\frac{1}{10}$ inch in length, g by a circular aperture at their widest extremity, and having urface wrinkled with irregular rings or annulations. In all ssential characters these tubes seem to agree with *Ortonia* but they differ in the very important point that they are not d to any foreign body, but, on the contrary, are perfectly free. ot think they can possibly be referred to *Tentaculites*, since e flexuous or in some cases irregularly curved, while they are te of the strong and regular annulations of the typical species s genus. Nor can they be referred to *Ortonia*, unless we that their occurrence in a free state is an accidental circum- due to their having become detached from the body on which rew, prior to fossilization. This is a possible explanation, . an unlikely one. At present I am inclined to believe that ve here a Tubicolar Annelide, which, like *Ditrupa*, was free t; but I shall delay naming and describing these remarkable until I may be provided with more ample materials.

EXPLANATION OF PLATE IV. FIGS. 2 AND 3.

2.—*a*, A group of the tubes of *Conchicolites corrugatus*, growing upon *Pleurotomaria bilix*, natural size.—*b*, A single tube of the same, enlarged.

3.—*a*, Tubes of *Ortonia minor*, Nich., growing upon a *Strophomena*, natural size. —*b*, One of the tubes enlarged.

III.—NOTES ON *CALCEOLA SANDALINA*, LAMARCK.

BY THE REV. T. R. R. STEBBING, M.A.

(PLATE V.)

ceola sandalina, both by its generic and specific name, means shoe or slipper. It is a common fossil in the Devonian rocks Eifel and other continental localities, and was found years Mr. Godwin-Austen at Ogwell, near Chircombe Bridge, in shire. Cuvier is said to have classed it with the Oysters, thus making it a bivalve; Lamarck placed it in his order Rudistes, of which Woodward writes that "they are the most problematic of all fossils;"[1] Davidson figures it in the General Introduction to his noble Monograph of the Fossil Brachiopoda of Great Britain, published by the Palæontographical Society in 1853. It has since then been transferred by the labours of Professors Suess and Lindström to the Zoantharia rugosa, which are commonly regarded as Corals.[2] There has been, therefore, a curious game of "hunt the slipper," not without some very interesting and instructive results.

Lindström's paper on the subject, translated by himself from the original Swedish, will be found in the GEOLOGICAL MAGAZINE for 1866.[2] Already, in 1853,[3] Davidson had remarked that of all the genera among the Brachiopoda, *Calceola* seemed the most abnormal; that no one had been able to point out the probable structure of the animal, nor its true position in the Class; that while so ponderous a shell demanded a powerful muscular system, no traces of such a system had been observed in the interior of the valves; and that in some examples so much calcareous matter had been deposited as to leave but little free space for lodging the animal. These acute observations must have led him to the very verge of discovering the true state of the case; but, unfortunately, Dr. Carpenter, whose paper "On the Intimate Structure of the Shells of Brachiopoda" is prefixed to Davidson's Monograph, though he examined several specimens of *Calceola sandalina,* did not meet with one in which the texture was sufficiently well preserved to enable him to speak positively as to its character.

Later on, Milne-Edwards seems to have had the clue in his hand, to have been "very warm," as children say in playing at "hide-and-seek." In placing the Silurian genus *Goniophyllum* among the Zoantharia rugosa, he tells us that it had been regarded as a Brachiopod shell, and that in fact it has some external resemblance to *Calceola* of Lamarck, but that the sections of it he had made left no doubt of its true affinities. Had he made similar sections of *Calceola* under favourable circumstances, he would have seen that its true affinities were just the same as those of *Goniophyllum,* the affinities of neither being with the Brachiopods, but of both with the Zoantharia rugosa.[4]

It may appear remarkable that so many keen observers should have mis-placed in the Molluscan sub-kingdom forms properly belonging to the sub-kingdom of the Cœlenterata, but there are extenuating circumstances. All the soft parts of the animals in question perished long ago; what was left looked much more like the shell of a Mollusc than the stony deposit of the Zoantharia. For several undoubted Brachiopods—*Spirifera exporrecta* (Silurian), *Cyrtina heteroclita* (Devonian), *Spirifera simplex* (Devonian), and others—had much the same general shape, while it was not known that any of the Rugosa had lids or opercula. Moreover, in most species of Zoantharia, when the calyx or cup is simple, that is, standing alone, its shape is approximately circular, whereas *Calceola sandalina* has one surface flattened, forming the sole of the slipper. A wrinkle running down the middle of this surface from the hinge to the apex, or pointed toe of the slipper, helped the deception, seeing that several Brachiopods have a narrow delta-shaped prominence in what seemed a corresponding situation on the ventral valve.

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[1] Manual of the Mollusca, by S. P. Woodward, 1851-56, part ii. p. 280; second edition, p. 441.

[2] Vol. III. p. 356, Pl. XIV. and p. 406.

[3] See "Fossil Brachiopoda of Great Britain," Davidson, in the Devonian series. Palæontographical vol. 1863, pub. 1865.

[4] Histoire des Coralliaires, vol. iii. p. 397.

According to Lindström it was Guettard who first made known the occurrence of an operculum among the Zoantharia rugosa. In all probability then Guettard is a very good observer, for, unless fortune be wonderfully kind, it requires excellent eyes to be able to see a thing through a heap of prepossessions. Milne-Edwards had perhaps an advantage in classifying Goniophyllum, in that, as it appears from his silence, he did not know of the existence of its operculum.[1] Thus he had one temptation the less to class it among the Brachiopoda. Since then several of the Rugosa have been determined to be operculiferous, in particular *Goniophyllum*, *Calceola sandalina*, and *Calceola Gotlandica*, which last Lindström re-names *Rhizophyllum Gotlandicum*, pointing out that its vesicular structure makes it a link between the Cyathophyllidæ and Cystiphyllidæ. By this structure and its rootlets, and possibly by its gemmation, it differs from *Calceola sandalina*, which in all other respects it closely resembles. But the rootlets, the vesicular structure, the mode of gemmation, all bind *Rhizophyllum* to the Rugosa ; and in whatever section *Rhizophyllum* stands, undoubtedly *Calceola* must stand with it. The rootlets are common to both the families above mentioned, so is the vesicular structure, some specimens of *Cyathophyllum* being so strongly vesiculose as to suggest a doubt whether the erection of the Cystiphyllidæ into a separate family be tenable. We all like sharp definition when it can be had, and disapprove, in a general way, of a creature which we cannot make out to be either fish, flesh, fowl, or good red herring; so that it is natural to feel a little spite against fossils of so slippery a nature that they come to us at first looking like Brachiopoda, and then prove to be Zoanthariæ, but so ill-disposed that they break up our family arrangements, separating what we had agreed to combine, and combining what we had agreed to separate. Nevertheless the supporters of a certain theory have a grim satisfaction when the discovery of new forms or improved classification links together species and genera, or even higher divisions, in a manner entirely consistent with the hypothesis of a common origin for large branches of the animal kingdom, but repugnant to the other hypothesis of an abrupt creation in accordance with definite types.

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[1] It may be doubted whether the *adult Goniophyllum pyramidale* really had an operculum after all! It is true Lindström figures a detached operculum which he refers to this genus (see GEOL. MAG. 1866, Vol. III. Pl. XIV. Figs. 6 and 7, p. 356), but out of several hundred specimens, obtained within the last five years from Dudley, not *one* possessed an operculum.—EDIT. GEOL. MAG.

The Zoantharia rugosa so often mentioned are invested with a wrinkled sheath or outside coating called the epitheca. Such a coating appertains to *Calceola sandalina*. In this, as in so many other species, the epitheca exhibits the lines of growth encircling the calyx. When the nap, so to speak, is worn off this outer garment, a threadbare appearance is presented, the lines running from the mouth of the calyx to the apex, representing, not the sculpture of a Brachiopod shell, but the outer edges of the septa, just as they are seen under similar circumstances in many of the allied genera. These septa are no mere surface-markings. A section made at about ¼ of an inch from the mouth of a large calyx, and parallel to it, shows them plainly in the interior, numbering about 160, or perhaps they are 80 with two laminæ apiece.

The Zoantharia rugosa are distinguished by a quadripartite arrangement of the septa. Such an arrangement is visible in *Calceola sandalina*. The section just described shows four depressions, two at the angles where the curve meets the flattened side, one in the centre of the curve, and the fourth in the centre of the flattened side.

The Zoantharia rugosa exhibit in many genera a structure as if many funnel or basin-shaped layers were packed inside one another. It is found very conspicuously in *Chonophyllum*, but also in *Goniophyllum*, in *Cyathophyllum*, in *Omphyma*, in *Strombodes*, and moreover in *Cystiphyllum*. It does not fail us in *Calceola sandalina*, the only difference being that there it is more neat and regular than in the other forms.

Looking now into the hollow of the calyx and to the inner surface of the operculum, we shall not only not find any traces of muscular impressions such as appear in Brachiopod shells, but we shall find that none such could ever have existed, for the whole of the inner surface of both calyx and operculum is seen, in the best-preserved specimens, to be occupied by the elevated edges of septa, or what in the operculum are the equivalents of septa.

A peculiarity not noticed by Lindström is that a small process rises up from the bottom of the cavity like a false columella. It would also appear, contrary to his supposition, that a depression actually exists in the centre of the flattened side, as before mentioned, although in perfect specimens a sort of plate or staple, consisting of two laminæ, takes the place of the depression in the upper part of the calyx.

The operculum is semicircular, coated with an epitheca showing numerous concentric lines of growth. Like the calyx, it has a flattened side, in form a very obtuse-angled equilateral triangle, with the hinge-line for its base. Its inner surface exhibits numerous septiform rays, which start from the hinge-line and reach the circumference, having a pinnate arrangement on either side of a large central ridge. The ridge itself is separated from the hinge-line by a pit or depression, which fits the top of the staple-like process in the calyx. The rays are prominent at the rim of the semicircle; along the hinge-line they seem to serve the purpose of minute hinge-teeth, projecting more or less alternately, one on either side of the central depression being especially prominent. At a little distance from the hinge-line and from the central ridge, several processes stand out conspicuously. These, as well as the hinge-teeth, fit into grooves and depressions in the framework of the calyx, at all stages of growth, as the sections of the calyx demonstrate. The attachment of the operculum, by means of these and the interlocking of the ridge and staple, must have been very secure, which will, no doubt, account for its being so much more frequently found in its native position upon the calyx than the operculum of any other rugose fossil.

We have refrained from applying to *Calceola* the convenient name of corals, because Lindström, following Agassiz, gives reasons of some weight for separating the Rugosa from the true polypes, and conjectures them to be allied rather to the Hydrozoa than to the Anthozoa. They would in that case be a link between the two classes. Quite recently Professor Allman has found reason to suspect that the Hydroida are connected with the Rhizopoda through the Graptolites. Thus link is added to link, and the chain will one day be perfect. But even if the theory, which the finding of these links and the perfecting of this chain helps to corroborate, prove in the end to be utterly untenable—if we see these links only because we wish to see them—if the landscape is coloured green only because we are looking at it through spectacles of that colour—still there is this immense advantage in a new and attractive hypothesis over an old unsubstantiated prejudice, that while the latter keeps our eyes shut or staring vacantly with blank gaze, the former opens them, quickens them to study and research, enables them to see the landscape and many of its beauties even if wrongly coloured, and, for one spectre of the imagination which it may call up, shows them a thousand useful realities.

EXPLANATION OF PLATE V.

Calceola sandalina, Lamarck, Devonian, Eifel.

FIG. 1. Section parallel to operculum, showing septa.
FIG. 1*a*. The same enlarged.
FIG. 2. Vertical section through the operculum and calyx at right-angles to the hinge-line.
FIG. 2*a*. The same enlarged.
FIG. 3. Flat side of calyx, showing the epitheca with its median ridge.
FIG. 3*a*. Front view of same specimen, showing the cavity of the calyx.
FIG. 3*b*. Side view of same.
FIG. 4. Section through operculum and calyx, parallel to the hinge-line.
FIG. 5. Young specimen, showing the large median septum.
FIG. 6. Flat side of calyx; epitheca worn away.
FIG. 7. Exterior of operculum.
FIG. 8. Interior of same. 8*a*. Operculum in profile.

IV.—ON SOME POINTS CONNECTED WITH THE DRIFT OF DERBYSHIRE AND YORKSHIRE.

By J. R. DAKYNS, Esq.,
H. M. Geological Survey of England and Wales.

IN a paper of mine on "The Glacial Phenomena of the Yorkshire Uplands," read before the Geological Society of London in the spring of 1872,[1] I compared the valley of the Wye in Derbyshire to those of the Aire and Calder in Yorkshire. This was a mistake: the Wye rises on the west side of the geological axis and crosses the anticlinal; but its valley does not cross the physical axis, which is nowhere broken through, as in the cases of the Aire and Calder. The lowest part of the watershed at the head of the Wye basin is at Doveholes, near Chapel-en-le-Frith. I made some observations by aneroid to ascertain the height of this point. The watershed south of Doveholes was by aneroid 1300 feet above the sea, and that north of Doveholes 1250 feet; but as the glass was falling on the day of my visit, these heights are too great by somewhat less than 75 feet, the total amount of the fall. This will make them between 1225 and 1300, and between 1175 and 1250 feet respectively. On another occasion I estimated the height of the watershed north of Doveholes at 1200 feet, and that on the Peak Forest Railway at 1175 feet. A couple of miles to the N.N.E. I found Sparrow Pit to be 1350 feet above the sea, and Perrydale 1200; the plateau above Perrydale 1350; the watershed under Mam Tor 1500; and the lowest point of Rushup Edge 1525 feet above the sea.

We may say then that the lowest part of the watershed north of Buxton is about 1200 feet above the sea.

The general mass of the Drift on the western side of the Pennine table-land reaches to the height of about 800 feet above the sea, though erratics are found at higher levels. In the Memoir of the Geological Survey on Sheets 81 N.E. and S.E., Mr. Green states that the depression of the land in glacial times exceeded 1200 feet. It cannot, however, have been much more than this, as no Drift has found its way over from the Etherow into the basin of the Don by way of Saltersbrook, where the height of the watershed is 1366 feet. Nothwithstanding this, and the total absence of Drift from the plateau of the Wye basin, where not even a solitary erratic is to be seen, I see no better explanation of the occurrence of Drift with foreign stones in the Wye valley than that given by Mr. Green in the Memoir alluded to above.

In the same paper I stated that, with the exception of some Silurian erratics near Threshfield, no foreign ones are found in Wharfedale. At that time I supposed these Silurians to be surface erratics, distinct from and subsequent in date to the general mass of Drift; but I afterwards found them imbedded in the regular Drift. The most northerly point at which they occur is near the Wharfe, a mile and a half above Threshfield: this is where the valley opens out on the west and merges into the Drift-covered plain that stretches from the Wharfe to beyond the Ribble; from this point the Silurian erratics can be traced nearly as far as Burnsall, where the valley of the Wharfe again contracts into a narrow dale, closely hemmed in by steep hills; and they are found, singularly enough, on the west side of the river only. They are not to be found on ascending the hills west by north of Threshfield above say 800 feet, though this is the direct way to the nearest outcrop of Silurian rock in place. Thus they occur solely in the Drift of the plain, and would seem to have come on floating ice; for it is pretty clear that they were not pushed by an ice-sheet over the fells, as they are not to be found anywhere on the high ground: and it is, in my opinion, quite impossible that the Ribblesdale glacier should, after debouching on the low ground at Settle, have spread out at right angles to its course for the distance of twelve miles.

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[1] See Quart. Journ Geol. Soc., 1872, vol. xxviii., p. 382.

The fact of these erratics being found only on the west side of the river shows that something barred their passage; this may have been a current issuing from the higher part of Wharfedale, which would then have been a fjord; or possibly an ice-sheet descended from the Grassington moors on the east; or an ice-foot clung to the coast; and thus the floating ice, laden with Silurian blocks from Ribblesdale, would be unable to reach the present left bank of the stream.

In the narrow part of the dale below Burnsall I have not found any foreigners; for this fact I can only account by supposing that that narrow channel was so blocked with ice descending from the neighbouring fells that there was no passage.

It is worthy of remark, with reference to these erratics being found up to 700 or 800 feet, that the mass of the marine drift in South Lancashire reaches an average height of 800 feet above the sea, and that the Eskers of the dales are found generally up to 700 or 800 feet, and further that 700 feet is the amount of the last submergence recognized in Norway. Thus we have evidence of a submergence to about the same amount in several localities.

Before concluding, I may say that I have just seen Mr. Wilson's interesting paper on the Formation of Rock Basins in Norway.[1] I think his suggestion well worth attending to; but I fear it will not help us much here, for we have piles of Drift where the beds could have presented no edges to the moving ice; and yet, from the position and extent of the Drift, we know that the boulders could not have been derived in all cases from the waste of cliffs falling on to the ice, for such did not exist, but must have been torn out by the ice from its rocky bed. It has often occurred to me that the bottom of a glacier being at the temperature of 32° F., as is shown by the existence of sub-glacial rivers, ordinary disintegration of the rocks by means of frost may go on beneath a glacier as in the open air; and thus we may account for the stones in Drift where there could have been no cliffs to afford ordinary moraine matter. The close jointing and numerous alternations of hard and soft beds in the case of the Carboniferous rocks would greatly facilitate such sub-glacial denudation, and such too would be the case, as Mr. Wilson suggests, where the beds presented their upturned edges to the moving ice.

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[1] See GEOL. MAG. 1872, Vol. IX., p. 481.

The vast numbers of well-rounded and scratched stones that occur in the Drift, and of which it is in fact in many cases mainly composed, have always been a great difficulty. Much has been written of late years about the moraine profonde, as such masses of Drift are now called: but no attempt has been made, that I am aware of, to explain in a definite manner the origin of such heaps of scratched gravel; it seems to have been thought sufficient to call them moraine profonde. This term, when originally used in Switzerland, was employed, as I am informed by one who is an authority on the subject, to describe the case of an advancing glacier overriding its own terminal moraine. In such a case no doubt the glacier might so grow as to shove its terminal moraine along in front of and partially beneath it: and the matter of the moraine would be greatly altered in nature and arrangement.

Doubtless also at the commencement of the Glacial epoch the ice as it advanced would sweep before it all the loose detritus from the hill-sides and beds of river-gravel or old sea-beaches; and in this progress the stones would get scratched and further rounded. But all such heaps of detritus must have been long since swept away from the hills and deposited mostly at the outskirts of the ice-sheet; and must now be sought perhaps in the vale of York. We must seek another way to account for the masses of scratched gravel and Boulder-clay found in the very heart of the fells. When these were formed and deposited, the country must have been entirely buried in ice, as Greenland now is. There could, therefore, have been no cliffs sticking through the ice to afford boulders for the Drift; we are thus driven to suppose that such boulders were derived from beneath the ice: and I see no means by which this could have been effected save by the disintegrating power of frost, aided in cases by a happy disposition of the chief divisional planes. But however difficult to account for, and however hard to conceive, I repeat the fact is certain that there has been an enormous amount of rock disintegrated sub-glacially, so as to form gravel and coarse stony detritus over and above the grinding of the rocks superficially into fine powder or mud.

V.—ON THE OCCURRENCE OF LEAD, ZINC, AND IRON ORES, IN SOME ROCKS OF CARBONIFEROUS AGE IN THE NORTH-WEST OF ENGLAND.

By CHARLES E. DE RANCE, F.G.S.

PART I.

IN former papers I have described central Lancashire as capable of division into three plains of different elevations. The lowest being often beneath high-water mark, and always below the 25-foot Ordnance contour; the second ranging from 25 and 50 feet to 500 feet above the sea, terminating at the foot of the steep escarpment at the western edge of the Lancashire and Yorkshire moorlands forming the Pendle portion of the Pennine chain, with an average elevaion of 1200 feet. Both the lower plains are much covered with rift, and the rock-surface at the sea-coast is often 50 feet below ow-water mark, steadily rising in one gradual inclined plain, astwards, or towards the Fells.

The lowest plain is covered with peat often 20 to 30 feet in thick-ess, resting on Cyclas and Scrobicularia Clays, which in their turn verlie the Post-glacial and marine Shirdley Hill Sand, which rising nto a line of ancient Sand Dunes along the landward edge of the peat at the base of an ancient cliff of Boulder-clay bounding the econd plain, in parts of which deep valleys have been entirely ut in the glacial drift, as the Ribble valley at Preston; and in other portions the Boulder-clays and interbedded sands and shingles have been re-excavated out of old Pre-glacial valleys.

Pendle range.—Between the Wigan and Blackburn coal-fields occurs a tract of elevated table-land, consisting of Millstone-grit more or less covered with peat and Boulder-clay with erratic stones, forming Anglezark, Withnell, Rivington, and other moors, with an average elevation of more than 1000 feet. This area, which has been brought up by great faults, is drained on the south by the river Douglas, which traverses the Wigan coal-field, and falls into the Ribble, whose tributary, the Darwen, receives the Roddlesworth, which drains the northern portion of the moors. This latter river, however, is in great measure absorbed by the Liverpool waterworks, and artificially carried south.

In making the "bye-wash" of one of the reservoirs for these works, near Lower Whitbank, Tockholes, on the Roddlesworth, a lode of galena was struck, ranging W. 25 N. Specimens of the ore were shown me by the lord of the manor, consisting of crystallized sulphide of lead of a bluish-grey colour, the back of the lode being quartz. The rocks in the nearest section I could find consisted of the basement-bed of the third (Millstone) Grit, dipping at 70° to the N. N. E., resting on Black Shales, containing "bullions," coated with thin seams of coal, with *Sigillaria* markings, dipping N. 30 E.

The hill-side, above the lode, dips with the beds towards the river at 7°, the lode, which appears to be in a fault, nearly corresponding in direction with the strike of the beds, running at the bottom of the valley, parallel with the stream. It is clear that under these conditions, all water falling upon the hill-slope above percolates into the porous sandstone, and will be intercepted by the fault, which, if consisting of an open fissure, would tend to be filled by any substance that the water could mechanically remove, or chemically unite with, from the grit and sandstone above.

Mr. W. Wallace, in his admirable work on Alston Moor, which I found invaluable when examining that district, gives four general laws governing the distribution of lead:—

1. That the quantity of water in circulation below the summit of a mountain, is "in inverse proportion to the depth from the surface, and in direct proportion to the distance from the watershed." Therefore, the greater the depth, the less the quantity; the further from the watershed the more the water.

2. The steeper the mountain slope, the less the water under it; the smaller the inclination, the more the water.

3. The freeness of circulation of water near the surface is directly proportional to the amount of inclination of beds, faults, joints, or veins towards the sides of a hill and *vice versâ*.

4. The greater the number of veins, faults, intersecting large lodes, etc., the greater the circulation, especially when corresponding to the dip of the strata, and therefore the greater chance of the lode to which they run being ore-bearing.

Having seen the truth of these laws as applied to lead in Alston Moor, I have felt much interest in endeavouring to find out how far they appear to apply to the occurrence of other metals and of lead in other districts.

The Roddlesworth lode, being at the bottom of the valley, away from the watershed, is favourable by "Law 1."[1] The slope is rather steep, which is slightly unfavourable by "Law 2." The dip is outwards, which is strongly unfavourable by "Law 3," and there are no tributary joints, lodes, or faults, which conditions are so unfavourable, as to lead to the idea either that these laws were inoperative, or that the lode was filled with lead before the valley was formed, and when the fault held back all the water falling on the ground to the west, which, percolating into the strata, would be tolerably favourable conditions for the deposition of lead, presuming it to be present, in the rock above, in a disseminated state.

On the south-west side of the same tract of country, east of Chorley, lead ores were formerly worked in a deep valley, on the western escarpment of Anglezark Moor, between White and Black Coppice. One of these old lines of pits is a W.S.W. lode, near Coppice Stile House, in beds of the basement-bed of the Millstone-grit, its eastern extension being cut off by a fault ranging N. 30 E., nearly parallel to which runs another short lead lode. Here the slope of the ground and the beds is towards the lode.[2]

A little further south, at Stronstrey Bank, there are several shafts in the Kinderscout-grit, from which sulphuret of lead, blende, and copper pyrites have been procured, and in one of which carbonate of baryta was first discovered by Dr. Withering, after whom it was named.[3]

At several points along the same line of country are east and west faults, at Thievley, four miles S.S.E. of Burnley, and 12 miles to the N.E. of the sections at Anglezark Moor, with a northerly downthrow of 340 yards, throwing the rough rock of the Millstone-grit, and the bottom beds of the Lower Coal-measures, against higher beds of the latter, and the basement bed of the Middle Coal-measures, on the breast of a hill called Deeplay Moor, nearly 1500 feet in height, the beds dipping into the hill, at low angles. Here the slope of the hill and fault is to the north, the lode ranging half-way across the hill, sloping down towards the Calder. The distance from the watershed is not great, nor are the other conditions very favourable; but as the works are now discontinued, the quantity of lead in the lode is probably not very great. But it is remarkable as being the highest lead-bearing horizon in the Carboniferous rocks of the district, with the exception of the Lead-mine Fault to the west at Hambledon Hill, about two miles east of Accrington, where the Arley Mine, the lowest coal of the Middle Coal-measure, is often permeated with strings of galena; and much lead occurs in the centre of the fault, which traverses the top of the hill at an elevation of 1330 feet, throwing the strata, which dip at a small angle to the south, 80 yards in the same direction.

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[1] "The Laws which regulate the Deposition of Lead Ore," 1861.

[2] These lodes are shown on the Geol. Survey of Lancashire, Six-inch Map, No. 78; they were mapped by Prof. Hull, F.R.S.

[3] Phillips' Introduction to Mineralogy, London, 1837.

The hill has a steep escarpment to the north, and is more or less isolated on either side, proving considerable denudation of rocks since the infilling of the fault with lode-stuff and other matter, for the fault and beds dipping from the escarpment give no gathering ground for water to pass through, and collect ore.

In a paper "on the Relative Age of the Lines of Elevation of the Carboniferous District of Lancashire and Yorkshire,"[1] Professor Hull has shown that the great series of E. N. E. anticlinal and synclinal folds exhibited in the hills of Millstone and Yoredale Grits, of the "Pendle Range," had taken place, and great denudation gone on, before the deposition of the Permian strata upon their upturned and denuded curves; and that a second system of disturbance (the Pennine), ranging nearly north and south, uplifted the Pennine Chain, dissevered the Lancashire and Yorkshire coal-fields at the close of the Permian era, which was followed long after, probably after the deposition of the Oolites, by a third system, of lines of fracture ranging N. N. W.

From the researches of Mr. J. M. Wilson, M.A.,[2] it appears probable, and even certain, that contortions are the inevitable results of subsidence of a curved surface, and that faults are cracks the result of the re-elevation of that curved surface, in which "the rocks have to expand, so as to fill a larger area." From which it would appear to follow that the curves of the Pendle range were the result of a subsidence taking place at the close of the Carboniferous era, accompanied by much marine denudation, produced by a sea, which on re-elevation became inland and land-locked.

The high range of Lower Carboniferous Fells which have been described as forming the eastern limit of the Lancashire coal-field northwards gradually approach nearer and nearer to the sea, the lower peat plain and the intermediate Boulder-clay terrace having been much denuded by the sea. These fells, which rise to a height of nearly 2000 feet, are a continuation of the Pendle range, and form the boundary between the counties of Lancashire and Yorkshire. The strata (as shown in the section given in fig. 1, p. 324 of Professor Hull's paper, before alluded to) of which these Fells are composed show a series of anticlinal and synclinal rolls, the former generally corresponding to valleys and the latter to hills. From the occurrence of patches of Permian here and there upon the upturned and denuded edges of the strata of the Lancashire coal-field, of sheets of Permian sandstone indiscriminately resting on the Lower Carboniferous plains of Furness and the Vale of Eden, on the denuded edges of the Coal-measures, Carboniferous Limestone, and Lower Silurian strata in West Cumberland, it is probable that north-western England had in many districts already attained much of its present configuration in pre-Permian times, with the all-important exception of the non-existence of the Pennine chain; though from my study of the Cross Fell district it appears to me possible that the post-Permian Pennine fault coincides with the line of an older unconformity and possibly a still older pre-Permian fault, of the same general age as the Pendle curvatures.

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[1] Quart. Journ. Geol. Soc., 1868, p. 323.

[2] Geol. Mag., 1868, p. 207.

The movement of subsidence at the close of the deposition of the Coal-measures was probably the means of producing "that excessive lateral pressure, by which the older underlying strata were squeezed and forced up into the series of sharp anticlinals forming the axis of the Mendips and Ardennes,"[1] and was the means of "throwing the rock-masses into a series of great folds, ranging from east to west, across North Lancashire and Yorkshire,"[2] and of exposing the strata, as it gradually sank beneath the level of the breakers, to an enormous amount of marine denudation, which affected not only the Carboniferous strata of the north-west of England, but the Lower Silurian tracts of West Cumberland, where the Permian strata rest transgressively on eroded Coal-measures, Mountain Limestone, Skiddaw Slates, and "Greenslate and Porphyries."

West Riding of Yorkshire.—One of the chief of these pre-Permian axes in the Pendle district passes through Clitheroe, bringing up the Mountain Limestone in that valley, as shown in fig. 1 of Prof. Hull's paper,[3] already so often alluded to, who also describes two other anticlinals, the Sykes and the Slaidburn, named by Mr. Tiddeman, of the Geological Survey, who surveyed them in detail.

The former axis has the effect of bringing it also to the surface, in the lower portion of the valleys of Sykes, Brennand, and Whitendale, drained by brook-tributaries of the Hodder, and in all of which are metalliferous lodes, which I have observed most minutely.

At Sykes I found the strata to consist of Upper Yoredale Grit (bottom beds), 240 feet. 2. "Whetstone Shales," with their siliceous seams, 100 feet. 3. Black Shales, locally called "Great Ironstone Shale," containing a band of black ferruginous compact cement-stone, 160 feet. 4. Thin fine-grained grit, locally "Trough House Rock," 30 feet. 4*a*. Black shale, "Trough House Black Shale," 20 feet. 4*b*. Thin flaggy grit, "Trough House Rag" (these beds are probably the Lower Yoredale Grit), 20 feet. 5. Black shales, with thick ruginous cement stone as base. 6. "Little Ironstone shale." 7. ystalline dark warm-grey limestone, weathering red, and decom- ing, locally "Red Bed Limestone," 80 feet. 7*a*. Dark black le, with occasional fragments of Encrinites, "Red Bed Shale," l "Little North Shale of Brennand Mine," 25 ft. 7*b*. Compact estone, seldom red ("Lower Post Limestone"), 78 ft. 8. Black careous shales, "Low Post Shale," with many bands of lime- ne, sometimes the latter predominating, which is the case Brennand Mine, 73 ft. 9. Black chert, "Bull-star Flint," ckness variable, running off in veins, average perhaps 20 feet. "Six-fathom Limestone," pale-grey colour and compact, 38 feet. Thick compact limestone, fossiliferous, certain beds containing ins and crystals of lead spread throughout the mass, locally called lve-fathom limestone. The lodes in it containing an almost imited quantity of barium sulphate, in fine radiating crystals, ich is often associated with crystals of fluor-spar, which are some- es colourless, and sprinkled over with crystals of lead-sulphide copper pyrites. Large quantities of the heavy spar occur on mine-heaps, in Losterdale brook, and on the roads, derived from source.

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[1] Mr. Prestwich, F.R.S., in Anniversary Address to the Geological Society, London, 1872, p. 65.

[2] Prof. Hull, F.R.S., Quart. Journ. Geol. Soc., 1868, p. 333.

[3] *Op cit.*, p. 324.

he valley of Sykes roughly resembles in shape the letter ⊃ ed on its side, in an E.N.E. direction, its long axis being the es anticlinal, the various beds, from 1 to 12, ranging in concentric ts, the oldest limestone being at the bottom on the west side, the er beds occurring above, and the Upper Yoredale Grit forming the of the fells, on either side of the valley, which is breached on the th (W. side of the ⊃) by the mountain pass, called "the Trough Bolland," and on the south (W. side of the ⊃) by the valley Langden and Losterdale Brook. On the east end of the ⊃, the ershed at Whin Brow, between Sykes and Brennand valleys, is 4 feet high, and is crossed by a path at 1450 feet, which descends Brennand House, by fine cliffs of Upper Yoredale Grit, forming a be-like hollow, surrounded by a large talus of fallen "screes." long the ridge above runs a fault, with an easterly downthrow 0 feet, which has the effect of throwing the base of the Upper edale Grit above the present level of the ground. It, however, ppears, and striking S.S.W. to Sykes Nab, where the grit is ersed by a small synclinal dipping S.E. at 75°, in the bank ve the road, and N. 35 W. at 15°, in the quarry nearer Hareden, re an impure freestone has been worked, which can in no way pare with the beds of similar age of Longridge.[1]

he basement beds of the Upper Yoredale Grit are well seen in the ugh of Bolland, where they were long ago described by Prof. llips in "The Geology of Yorkshire," where also may be found ection of the anticlinal in the limestone, traversed by a lode, ning parallel with it.

he black shales are well seen near Turner Hill (at a height of 4 feet by the aneroid), where the beds are rolling, and contain numerous carbonaceous and siliceous nodules, sulphur-partings, and the water that flows out of them is slightly impregnated with a mineral oil. The cement-stone is about four feet in thickness, and dips east of Nab House at 11° to the south-east; and on the opposite side of the valley, at Trough House, in the reverse direction.[1] The Lower Yoredale Grit occupies a narrow belt of country surrounding the various bands of limestone, &c., with the lowest and oldest at Crag Wood towards the centre; the whole series, from the Lower Yoredale Grit to the twelve-fathom limestone, forming a rough parallelogram one mile in length, and half in breadth, the long axis of which, the Sykes anticlinal, runs in a direction N. 30 E.

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[1] This fault was first made out by Mr. Hudson, who made a mineral survey of the ict for the lord of the manor.

Near Sniddle Holes, between Trough of Bolland and Whin Brow, two poor lodes occur in the shales, running E. 28° N., nearly parallel to each other, 140 feet apart. The Trough House north lode contains bisulphide of copper and iron; the south lode galena, blende, and iron and copper pyrites.[2] The two lodes hade towards each other, and form a small "trough fault," running with the strike of the rocks and hill-sides, with an inward dip, circumstances tending to a small circulation of water, an adverse condition for a rich lode, according to Mr. Wallace's Laws, there being no gathering for water in consequence of the slope.

The ore in the present instance must have been entirely introduced before the denudation of the Sykes valley, and must have been derived from the Upper Yoredale Grit, or higher formations.

The Trough House rock, and accompanying black shale, which contains a great quantity of sulphur, is well seen at Ram's Clough, 25 feet of grit being visible, dipping 22° at N. 40 W., and 12 feet of the black shales near the barn by the foot-bridge.

The cement-stone, lying above the Red Bed Limestone, consists of three beds of an aggregate thickness of 9 or 10 feet; it is well exposed along the course of Penny brook, near the cart-way from Nab House, where the dip is S.E. at 30°. Still higher up, where a brook branches off to the right, it is E.S.E. at 35°. A specimen I procured of this rock yielded on analysis 7 per cent. of metallic iron.

The basement beds of the Limestone shales, lying above the Bull-scar chert, are well seen in Ram's Clough, east of Sykes. Above the chert is 20 feet of Low Post shales and limestone bands, the shales being from 6 to 12 inches, the limestone from 2 to 3 inches, on which rests an earthy dark limestone, 14 inches thick, completely full of crinoid stems, on which rest 190 feet of shales and limestone bands, and Lower Post limestone.

Good sections of the limestones occur in Bracken hill, above the quarries, which are situated in the "Twelve-fathom," dipping 8° to the West. The surface of the rock in one bed is completely sprinkled rith crystals of galena. Below this seam occurs an Encrinital band ight feet thick, resting on a Coral bed two feet thick. The lowest ed seen is often of an apparently brecciated character, the fragments eing slightly dolomitized. Higher up the hill the six-fathom limeone dips 17° to the W., and a little further south the axis is ached, which passes *obliquely* across the valley, giving at first sight n appearance of a fault passing down the valley. The anticlinal arch well seen in the quarry on the east side, a little north of which, ear Cragg Wood, a small lode was once worked, running N. 60 E., rith a southerly downthrow, containing blende, calamine, and opper pyrites. South of the axis by the brook the dip of the beds S. 60 E.

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[1] As the whole of this district is now, I believe, being surveyed by my colleague, Mr. Tiddeman, I have omitted as much as possible all reference to the rocks and details of the geology, except such as have direct bearing on the distribution of ore in the lodes, to which I have there especially directed my attention.—C. E. R.

[2] A mass of copper pyrites was found on the opposite side of the valley, near the cement-stone bed, but it may have been brought there by glacial action.

A well-marked lode (fault) has been worked on both the west nd the east side of the road. The "foot-wall" is particularly smooth, overed with slickenside, and hades South at 52°. On the east side f the road the lode has been driven on for a distance of 108 fathoms, ommencing in a direction E. 36 N. At 13 fathoms from daylight a ross fault-lode comes in, running N. 35 W., on which a "sump" was unk, 18 feet in depth, from which much lead was procured, but hich had to be stopped in consequence of the large influx of water, e bottom being beneath the level of Losterdale Brook, draining the alley. The southern prolongation of this fault is cut off by the ain lode, which is the case also with another small lode ranging . 16 W., 80 fathoms distant from the entrance of the level; which, n the opposite side of the road, ranges W. 26 S., and has been riven westwards 69 fathoms. This productive lode is remarkablo r being a strike-fault nearly coincident with the anticlinal axis.[1]

Following the Sykes anticlinal to the north-east, it passes across rennand valley, and rises a little north of Brennand House, and runs outh of, and nearly parallel with, the adit-level at Brennand mine, o. 1 level of which is driven right through it. From this point runs across "the col," or depression in the range of hills intervening between Brennand and Whitendale valleys. This col is overed with a thick deposit of peat, resting on a yellow stiff clay, ontaining, near the lodes, much lead and vein-stuff. In the centre the reservoir for the mine, supplying the hydraulic pumping and auling engines, the bottom of which was cut down to the rock, hich was found to be limestone, traversed by a lode, ranging . 20 E., proving that the limestone tract of Brennand is continuous cross the col with that of Whitendale, the limestone tract at the eservoir being 100 yards in width at Brennand river; measured cross the axis it is 750 yards in width, at Whitendalo 600.

The south side of the col is bounded by Middle Knoll, at the top f which the Yoredale Grit has been quarried.

The Limestone tract of Brennand and Whitendale may be therere compared to an elliptical boss, of which the major axis is the ykes anticlinal, and the minor (which is more the result of the form of the ground than an actual roll of the strata), a line running with the Brennand Lode across the mine. This lode has a direction W.N.W., and is a downthrow of seven yards to the N.E. It is worked for lead in the mine (of the Whitewell Mining Company), which consists of an engine-shaft and air-levels, from the fifth of which an adit-level, half a mile in length, connects the mine with the lower part of the valley. The hade or inclination of the lode is on an average 55° from the horizontal; but I found it in some parts of the mine, in soft shale, to be 38°, and in hard limestone to be as high as 84°, being especially steep between levels 4 and 5. Level 1 is carried right through the axis, the bed commencing and ending in the Red Bed Limestone, with a boss of lower shaly limestone in the centre. Up to the present time the lode has only been worked on the western side of the axis, the western end of the levels being driven up to the "Bolland Shales," passing through shaley limestones, lower post limestones, and very productive red-beds, with an intercalated unproductive shale-bed in its upper part, locally called "Little North Shale." The shift of this shale in the various levels enabled me to calculate the throw of the fault.

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[1] These sections were visited and viewed with much interest by the late Sir oderick Murchison, who was of opinion that the valley is due to a fault running ong it.

When the lode passes through shale-beds it is much squeezed, and indeed almost invisible; with shale on one "cheek," and limestone on the other, the lode is invariably poor. With limestone to limestone, the lode is well defined, filled with lead and other foreign matter, often with spaces or hollows (locally called "loughs"), the sides of which are covered in No. 5 South, with brilliant crystals of carbonate of lime, facing towards the hollow, resting on a "foot-wall" of iron-pyrites, beautifully indented with slickenside. The beds here are dark and compact, occasionally iron-stained, and contain both in levels 5 and 6 a great quantity of blende in large masses. With Red Bed Limestone on both cheeks the lode is productive of galena, as much as five tons having been taken from one spot. The Chert beds which are productive of lead at Sykes have not yet been reached in this mine. The limestones associated with the cherts on this horizon appear to a great extent peculiar to the district, and unlike the 12-fathom limestone which persists through West Yorkshire, (uppermost of the "Scar" and "Cam" limestones, "Main" limestone, 82 feet of Swaledale),[1] into Alston Moor, on the Cumberland and Durham borders.

The Red Bed Limestone is seen in Swine Clough, on the west side of the valley, and is there traversed by a lode which slightly faults the rocks, and runs under the barn, where it throws out a copious spring of water. and probably continues across the river in an

[1] In Swaledale, above the Main limestone, is the main chert, black beds, plate, red beds (15 feet), plate, and 60 feet of white grit. The grits and the cherts are lead-bearing, and the white grit is spoken of by Professor Phillips (Geology of Yorkshire) as the probable equivalent to the "Bearing Grit" of Nidderdale, and the fire-stone of Alston Moor. In Stonesdale the corresponding beds are known as the Lower Chert series, containing more plate than limestone, throughout the whole of northern Yorkshire, one or more horizons of Chert occur above the 12-fathom limestone. In Northern Yorkshire and Westmoreland, and in Cumberland, shale is called "plate," and sandstone "hazel," solid compact beds of limestone or sandstone "posts."

N. E. direction to the west of Blue Scar, where it joins, or rather omes the Whitendale lode. The top of the Red Bed Limestone in ine Clough is 850 feet above the sea; 70 feet above it was found nass of lead, with Red Bed Limestone attached, which may have n lifted and left there by glacial action; for a little further south the Clough I found a rounded and scratched trap pebble, at a ght of 755 feet above the sea. The limestone at the Swine Clough e dips N. 10 W. at 35°.

[n the river between the footbridge and the lime-pits a small iclinal roll striking N. 15 E. occurs; but further up the bank near Pasture Clough the dip is normal, being N. 60 W. at 70°, which lso found in the "Hush levels."[1] These were driven, I believe, at end of the last century, by "the Old Men"; they are very low, l were entirely cut with the pick, no drill-made hole, or other trace owder being apparent, nor is there any sign of a lode; the levels nch in a tree-like form from the entrance, one of the branches ending over Brennand Level.[2]

Iigher up on the hill, towards the top, between Brennand valley Whitendale, lead was found in Hush-water Syke, and still her up, at a place called "The Calf-hole," very large lumps of l were taken out many years ago. This was probably a pocket of , and not a regular vein.

The lowest limestone seen in Brennand and Whitendale rivers is 'Lower Post.' Several small lodes occur in it at Whitendale, ning E. 10 S., and N. 15 W. The Whitendale great lode[3] being he Red Bed limestone, dipping E. 10 S. at 55°, near the entrance, lode ranges in a general direction W.S.W., hading south at 78°, 37° in the middle, and at 70° at the end, which is 76 yards from entrance.

'his lode runs nearly parallel with the axis, about 100 yards south t, with the strata dipping from the axis to the lode, consisting Red Bed Limestone, which is considered a good rock for lead. 'ertheless, though the conditions here are rather favourable for the osition of lead, from the tolerably free circulation of water, very le occurred in the lode, as far as the level is driven on it, though it tains a very large quantity of blende; the centre of the lode ıg, it is said, composed of a width of four or five feet of it.

'his ore does not pay to work in the valleys, owing to the distance a a railway. Calamine, however, was worked many years ago, he west bank of the Hodder, opposite Whitewell, on the slope of hills, in a series of shallow shafts, excavated in rolling moun- limestone beds, which, from the information I have received from e who remember the work being carried on, appear to have ı sunk on "sops" or pockets of metal, and not on any regular lode. In the whole of the district, where the carbonate of zinc has occurred, it has been as a surface metal, while the sulphuret is more often found in depth. Both ores of zinc are found in shaley-limestone and shales, in which lead would hardly ever occur.

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[1] A "Hush," in the north-west of England, is a deep trench dug on a hill-side, to lodes.

[2] A plan of these curious old workings was made for me by Mr. Hoyle, of the itewell Mining Company.

[3] The following magnetic dialling, taken for me by Mr. Hoyle, is curious as showing and comparatively sharp turns, in this lode-fault:—From entrance N.W. 72°, 3in.; N.W. 83°, 55ft.; S.W. 81°, 80ft.; West, 23ft. 5in.; N.W. 85°, 45ft. 8in.

At Brennand, the chief lead lode crosses the anticlinal, nearly at right angles, while the Whitendale zinc lode runs nearly parallel to it. There is reason to believe that the latter is the same lode that is lead-bearing at Swine Clough, on the opposite side of Brennand river. If so, it must either cross, or terminate the southern prolongation of Brennand lode, the latter being most probable, as no trace of the fault can be found on the face of Mellor Knoll. The Whitendale lode is probably newer than that of Brennand, the magnetic east and west lode being older than the magnetic north and south lode.

The surface of the ground, at the bottom of the col between Brennand and Whitendale valleys, consisted of the uppermost beds of limestone, the overlying shales having been denuded, and carried away down to the level of the limestone. As the lodes traversing these upper limestones are highly productive of lead, it would appear probable that the ore was introduced before the denudation of the col, when the upward prolongation of the faults, in the shales, were still open fissures.

To sum up the general results derived from an examination of the Sykes, Brennand, and Whitendale lodes, those running across the anticlinal axis are productive of lead; those with the strike of the beds of zinc, and at Sykes of lead and baryta, the quantity of ore being determined more by the nature of the matrix than by the distance from the watershed and from the surface.

(To be continued).

VI.—EARTHQUAKES.

By H. P. MALET, ESQ.

THERE have been several Earthquakes lately, and they are still attributed to volcanic action. As the *Quarterly Review* of 1st January, 1869, tells us, the most popular notion regarding these phenomena "*is the hypothesis of contraction of the mass of this globe by radiation of heat into space.*" If we examine this sentence by geological reasoning, confining ourselves to those things, and actions, which are visible, and tangible, we find two causes of objection to it. We ask, whence is the heat to radiate into space? and where is the mass capable of contraction? There are certain laws which rule atoms, and worlds; we have only to understand these laws, and their effects, to enable us to comprehend every phenomena upon earth; man has not been able to do this, but has sought interpretations from his own imagination, till he has been led into innumerable difficulties. Man has been trying to find out an imaginary self-existing fire in the centre of this globe for more than 2000 years without success, he does not like to give it up, as it is a very convenient, and irresponsible agent; so at this present moment the Underground Committee of the British Association are ex-

·imentalizing for it on the Wealds of Kent.[1] The results of the our can be anticipated, a higher temperature will be found with ›th, but not so great as in a coal-mine. Heat must be found, ; as good reasons have been placed before the world, that this ıt originates in local causes, we will accept them till they are ›ved erroneous, or till a self-existing fire is discovered, and the mean time we assert that there is no proof of *radiation of ıt into space* from the interior of this earth.

Man has long imagined that the substance of this earth, beneath the limentary strata resting on it, is one uniform, all-pervading, all-rounding envelope, commonly called "*The Crust.*" Its interior face ıupposed to rest on the central fire, and to be always in a molten ıdition at some 25 miles beneath our feet; as this heat decreases distance from the fire, the outer face naturally contracts on cool- ;. This contraction has been supposed to cause earthquakes, and ›xpel the molten matter from 25 miles distance up to the surface. A popular notion is a very unsafe mooring, and not one in ten ıusand of those to whom the *Quarterly* alludes could tell us how formed that notion. Nevertheless it is popular; and its popu- ity is due to the fact, that there never was a time in English tory, when men followed the lead so blindfold as they now do. 'ew eminent pens have written out the theory, they have described touching language how various surface phenomena have been ısed by the contraction of the crust, scientific pens have shown t this crust must be nearer to the surface in some places than in ers, under the ordinary process of denudation; the *Quarterly* ows his weighty pen into the scale, and so we have a popular nion, founding a surface phenomenon, which we see, and feel, on ;rust which is not known to exist, of which there is neither asurement nor knowledge. If there was any doubt or uncertainty the opinion we might excuse it, but what can we say to the ›l pen that writes, "*This Earth was once an igneous globe,*"—"*There ıe to be formed a solid shell,*"—then a "*cracking*" and "*crumpling*" the Earth into its present irregular surface, for in those days ıere were earthquakes on the grandest scale"? This sounds very ;iting, but it is all imagination.

There are certain fixed laws which tyrannize over this world, atoms could not be as they are without these laws, and the 's could not exist without the atoms. These laws are 'ond our control, for we, in our persons, are as liable to m as an atom of dust, or as the mass of the Andes. In the ıes, 4th October, 1872, it is shown that Quito has sunk 246 ; in 125 years, Pichincha 218 feet in the same period, and tisana 165 feet in 64 years; if we take away the support of atom, it falls till it finds another, if a man loses his footing falls, there is a perpetual wearing away of subterranean, as l as of surface matter, so that supports are perpetually failing, l everything is liable to the laws of gravitation, even to the hest mountains of the earth.

Mr. Malet has evidently been *misinformed* as to the *real objects* of the Sub-Wealden loration.—EDIT. GEOL. MAG.

There are natural forces always at work, which bring matter under the law. The wind lifts up dust from the earth, and some of it falls again. The rain falls to the ground, and percolating through it till it finds an impermeable stratum, gravitates along its surface till a level is found. Wherever we find water in a moving condition, we see that matter moves along with it. Water and air move all things that submit to their influence, every thing, that is so moved, becomes, sooner or later, liable to the law of gravitation.

Certain materials in this earth, under certain conditions, are liable to the law of attraction; while under this influence they become more or less liable to gravitate. In the natural deposits of matter we find heterogeneous mixtures, but as the silex separates itself from the chalk, as ironstone nodules form in sand and clay, as chert-bands form in limestone, by self-attraction and cohesion; so atoms must be perpetually moving, and every atom that moves voluntarily must leave its place unoccupied, while the place of any atom moved by force is occupied by the substance which exercised the force, air or water. Wherever subterranean water runs it must act as it acts on the surface, eroding, and moving on something in every inch of its progress. The water occupies the place of all things moved by it, but atoms are eroded from the body they belonged to. Under the action of these never-wearying forces, certain areas, or portions of this earth's surface, must occasionally be left without their natural supports, and their self-sustaining adhesive qualities; so that these areas or portions, either in part or whole, become liable to the law of gravitation. With pressure from above, no support, or a soft one below, and a material deprived of its adhesive power, there is, there always has been, and there always will be, a universal tendency for earthy matter to work downwards.

This tendency may be illustrated by the following examples. The *Athenæum*, 9th October, 1869, mentioned an earthquake at Murwut East India, where the "underground moisture is commonly found two feet below the surface;" it rose after the earthquake to "about six inches below the surface, not in one spot only, but throughout the sandy tract of the district." In this case the sand, being dry and untenacious, without sufficient support for its weight, sunk bodily into the water-bed; so that the moisture rose to near the surface. This action is very common in sandy regions, but is seldom noticed, even in our footprints. In the *Times*, 6th July, 1871, an earthquake is recorded at Bathung, in China, over an area of some 400 miles, when "black fetid water spouted out in a furious manner." The nature of the soil is not mentioned, but it fell into, and displaced the water below; so that, having no other channel of escape, it was forcibly ejected through the crevices made by the fall.

In 1783–86 constant shocks of earthquake took place in Calabria, with upbursts of water and sand," "not fewer than 215 lakes and morasses were occasioned by displacement of the ground." The *Quarterly* also says of other regions, "Violent vibrations, down-sliding of hills, stoppage of rivers, formations of lakes, in-rushing of sea-waves have taken place."

All these cases, and many more might be added, illustrate the subsidence of the upper strata into the water-bed; if the phenomena had been caused by the contraction of the cold crust, as so many imagine, the water must have gone down through the cracks of that contraction; if, on the contrary, they had been caused by the subsidence and shrinkage of the earth's exterior, as asserted by Mr. R. Mallet, *Spectator*, 5th October, 1872, into the "retreating nucleus," then again there would necessarily be fissures below the water run, and, as there would be no force to eject it, all the water on the site must of necessity have gone down; so that there is no escape from the conclusion that earthquakes may originate in the mass of matter overlying the water-bed, and that they have no necessary connexion with volcanoes. Earthquakes that happen without water ejection are by no means dependent on any igneous action, or on any contraction of the earth-rocks below, as the following example will show:—On the 17th March, 1871, an earthquake was reported in the lake districts. The *Times*, of April 3rd, admitted a letter saying, that this earthquake was attended with "a concentrated hissing sound." On the 25th March the *Kendal Mercury* printed a letter which thus explains the phenomenon:—"We had a dry summer last year, our springs sank unusually low, our winter snow and late rains have now percolated into the strata above the subterranean water-levels, and the extra weight of the water has forced these strata into the beds or cavities below,"—an action corresponding to what we have said, and one that must of necessity force out the air or gases, which had collected in the empty water runs, the hissing sound depending on the character of the orifice through which it was expressed. It will be understood that this expulsion of air is precisely similar to those actions, which eject gases from the surface in many parts of the world; though the subsidence which supplies the force may be either sudden or slow. There are many instances where other matter than water or air is acted on by landslips, subsidences, or earthquakes. In the Under Cliff, Isle of Wight, and near Folkestone, great masses of cliff have slipped bodily into the black Gault below, and this mud, full of fossil-remains, has been forced up through the crevices, and in great masses, along the face of the broken cliff, where it joins the sands of the sea-shore. At a considerable distance from that line, at Folkestone, a ridge was forced up on the sands near low-water mark, equal in length, and parallel to the landslip. Tides and waves had nearly obliterated this ridge, when we examined it, but the sheet of black Gault which had been forced down the water runs was still visible in places, of varied thickness; explaining how sheets of one material become interstratified with other materials, for which science has as yet found no explanation. The elevation of the line of sea-shore in Chili, in 1822, and the upheaval of the Ullah Bund, in India, in 1819, are both actions of a similar nature, and no similar elevation of the surface earth can be attributed to any other cause, than a corresponding subsidence; so that in all these and in many more instances we confirm the opinion of Professor Haughton, who said of other cases, "Their characters are totally different from those of volcanic phenomena," "showing the two classes of phenomena have a different seat."

There is then trustworthy evidence to show, that earthquakes do not necessarily depend on *volcanoes*, or the *contraction* of the mass of this globe by radiation of heat into space, or by the *shrinkage* of the earth's exterior into the retreating nucleus; but we must briefly examine how far volcanoes may be dependent on earthquakes.

Science has not made up its mind as to the origin of these igneous phenomena. The *Spectator*, of 5th October, 1872, discards one fashionable theory thus, "It is now generally admitted that if the earth really has a molten nucleus, the solid crust must nevertheless be far too thick to be in any way disturbed by changes affecting the liquid matter beneath." Another theory of local molten basins he disposes of by saying, that "such lakes could not maintain their heat for ages." It is now some years since we discarded these theories in "The Interior of the Earth." The *Spectator*, however, says, "A theory has just been put forward by the eminent seismologist, Mallet, which promises not merely to take place of all others, but to gain a degree of acceptance, which has not been accorded to any theory previously enunciated." While fully allowing the position assigned to Mr. R. Mallet, and giving him full credit for accuracy of observation, experiment, and calculation, we must take the liberty of examining this theory so far as it is set before us. It is shown "that the hotter internal portion must contract faster than the relatively cool crust," and so "the shrinking of the crust is competent to occasion all the known phenomena of volcanic action;" "as the solid crust closes in upon the shrinking nucleus," the crushing induces heat, and so "the access of water to such points determines volcanic eruption." If by the solid crust of the earth is meant a substance similar to any of the rocks we fall in with on the surface, then there is no evidence to show that the crust is continuous, or solid, while nothing but a continuous solid rock could meet the theory. If again this is the substance alluded to, we have evidence to show that the void hard rock is cooler at a depth of some 5000 feet, than in coal-mines at 2000 feet, so where does the supposed contraction begin? We rather think that Mr. Mallet has done more to destroy the great myth of internal self-existing fire, than any one of the Plutonic school has done to keep it alive.

With these brief remarks we pass on to our little history. We do not demand credence to it; the facts are before us, always in action. We only ask those who take an interest in the subject to think for themselves, and, sooner or later, they will recognize the picture before them. The inhabitants of volcanic regions, on hearing grumblings, and feeling vibrations, say, "The mountain is in labour." We all see what vast collections of matter are brought together by the water drifts. We know that, season after season, materials of one description are brought to the same spot, and we see on our cliffs, and in our mine shafts, the thickness of these strata. We know at out of these strata, and these deposits, man obtains combustible d inflammable materials, yet has he been unwilling to allow that ture's laboratory is equal to his own. Some have rejected the tural chemical theory of Sir Humphry Davy and others, that lcanic action depends on local chemical causes. It has been boldly d falsely asserted that the cause was not equal to the effect, and at the chemical energies of our earth's materials were almost holly exhausted before the surface was consolidated. Nevertheless, e hot spring flows, and the mountain labours. There may be local haustion, but the energies of the earth are never lost, though they ay change from the inanimate to the animate, and back again. et those who suffer from these active energies talk of nature's haustion if they please, but those who sit in their rooms, and eorize on the subject, may as well hold their peace. Who will nture to limit the quantity of any material, igneous or not, which ay have been collected into one region by the natural forces work-ig at it for unknown millions of years? The earth is full of kalis, as well as of gaseous materials. Spontaneous combustion kes place in the little cargoes of our ships. Can we refuse a milar faculty to the great collections of the earth? The material all the same; nothing is hid in the strata of this earth that as not once a partner in its surface produce, and nothing but rth's produce takes fire in a ship's hold. We can neither limit the llection of matter, or measure the energy of a collection. The ountain in eruption discloses that, and the extinct volcanoes tell of cal exhaustion. If volcanoes were caused by the issue of heat from e imaginary furnace of the earth, if the shrinking of the inner rust produced mechanical causes of heat, and these were converted to flames or steam by contact with water, there would be no cause hy an eruption, once commenced, should ever cease. We know e force with which heat flies to a cooler atmosphere; a channel, nce opened to that fire region, could never close again, eruptions ould never cease, and lava would flow while there was granite or asalt to melt. Volcanic action is, however, spasmodic, and craters o close up; and so we at once come back to the earthquake cause of e volcano. We have got our heating substances inside the earth, e have got water percolating through the earth, we have vacant reas beneath the surface. Along these water-courses, and into these reas, the earth subsides or falls. There is no choice of locality for ese actions. The sandy plain, and the highest mountains in the orld, are alike liable to the law, and thus earthquakes are felt in olcanic regions previous to eruptions.[1] It is only in these regions at this effect takes place, and in these nature has deposited the aterials which produce heat. These materials are as liable to the elf-attraction of atoms, and to the eroding action of water, as any ther materials; they are therefore as liable to the laws of gravitation. he grumblings and vibrations felt on the surface must be caused by this law, in the act of placing heating matter under the influence of water. At this point we meet other geologists; the only difference between us is, that our material falls into the water; while their water falls into the fire. We believe that we have already opposed insurmountable obstacles to this action; but we will now say, that if the heat below our feet is a gradual progressing one, till at 25 miles, or thereabouts, it could melt the hardest rocks, and if the contact of water with these rocks is a necessary prelude to an earthquake or a volcano, then neither of these phenomena could ever have been seen or felt upon earth. If the water that percolates through the strata could by any possibility reach the imaginary molten rocks, the action of the volcano would be regular, and could never cease; its action is however spasmodic, at long intervals, indicating fresh energies; these must be supplied by new matter as shown above; when this is burnt out the spasm ceases, and so a volcano sleeps and wakes, till no more heating materials are available.

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[1] These actions are confirmed by the *Times*, of 1st November, 1872: "Advices om the Sandwich Islands report the volcanoes of Mauna Loa Kilauea in a state of tive eruption, and it is stated that the shores of the island are sinking."

We have thus briefly and imperfectly given an interpretation of phenomena which happen on the surface of this earth. In endeavouring to fathom their causes, it seems that people have been led away from Nature's laws, and have tried to explain the subject by bringing in an agent, whose existence is not proved. The new theory, noticed by the *Spectator*, is only one more proof of the unsatisfactory explanations dependent on an imaginary self-existent heat. Till this heat is proved to exist, every theory based upon it must be rejected, and the greater necessity is there of determined rejection, when we find that these phenomena can be interpreted by natural laws.

While the sun shines, and rain falls, while the earth and the water produce, while these productions pass on to burial, so long will combustible matter be passed on by water, attraction, pressure, and gravitation to its peculiar burying-grounds; where, sooner or later, it will again be made use of to produce phenomena, which have been so little understood.

We walk along the ocean shore, or by the river bank, we see the atoms moved along, we watch the landslips, and the avalanche, we walk on the dry sand and see the water rise in our footprint, and we see in these familiar scenes details of those vast actions which are for ever at work somewhere. We have only to expand our minds to keep pace with these actions, which we call phenomena. All the agents we use are visible, all the materials are tangible; a geologist has no business with the intangible or the invisible. For more than 2000 years man has been seeking for a self-existent fire beneath our feet without success; he has found some heat in the earth, where it must necessarily be under the ordinary laws of pressure, with certain conditions of deposits. Man has not gone beyond deposits, and has no right to assume a state of things in a locality of which he is ignorant. So we come to our simple conclusion. The Earthquake takes place, when the area becomes liable to the law of gravitation, and falls, as a snow avalanche falls over the face of a precipice, because it cannot help it.

NOTICES OF MEMOIRS.

I.—On *Palæmon exul*, a New Crustacean from the Polirschiefer of Kutschlin, near Bilin, in Bohemia. By Professor Dr. Anton Fric.

THE thorax is eight mm. long, and three mm. broad; the mesial line of the front part shows a high crest, which bears six spines, pointing towards the rostrum. On each side of the crest are situated what appear to be the eyes; the facettes of which, however, cannot be identified. The inner antennæ have a three-jointed basal-portion; only two of the whips (Geissel) are preserved. These are of the length of the thorax, the outer one being considerably stronger than the inner one. Of the third whip (Geissel), which true Palæmons do not possess, Dr. Fric can only detect a rudiment. The outer antennæ have a large scale at their base, which covers about ten joints of the antennæ. The whip is much stronger than those of the inner antennæ. The first pair of legs is small. The second is the strongest, and bears small chelæ, and projects five mm. beyond the margin of the thorax. The third and fourth pairs are weak; the fifth of double the strength and size of the previous one. The abdominal segments agree exactly in outline with those of *Palæmon;* as also do the five-leafed tail-fin.

The discovery of this exquisite marine crustacean in a freshwater deposit is very remarkable. After the upheaval of continents small basins of saltwater sometimes remain inland, which after a time lose their salt; in consequence of which the marine animals living therein either die out or become naturalized in the freshwater. So we find the genera *Idothæa*, *Sphæroma*, and *Gammarus*, in the rivers and lakes of Tuscany, and *Mysis* in the lakes of Sweden. Also the Adelsberg caves have their blind *Palæmon—Troglocharis Schmidti.* It is interesting to know that the recently-discovered Crustacean from Ob. Nowall, near Waltsh, resembles more a marine millipede than a land millipede.

II.—On the Agricultural Geology of the Weald. By W. Topley, F.G.S. From the Journ. Royal Agric. Soc., vol. viii. 1872.

THE Wealds of Kent, Surrey, and Sussex, with their border-lands of hill and vale, have such special interest for the geologist that we welcome every good addition to our knowledge of this portion of England and every aid to the advancement of that knowledge. Mr. Topley, especially addressing agriculturists in this pamphlet, gives accurate geological information in text, tables, and coloured map, which will be fully appreciated by geologists. We already possess, as an important aid in study, the somewhat smaller, but beautifully perfect, map constructed by Mr. W. Whitaker for the

"Report of the Medical Officer of the Privy Council." 1868; and now some very useful and accurate Geological Models of the South-east of England, by Messrs. Topley and Jordan, are published by Stanford of Charing Cross: and these, with the Maps and Sections of the Geological Survey, enable the student to master most of the difficulties and complications that affect this classic area, which indeed becomes more and more an object of interest on account of the boring exploration through its lower stages in progress at the present time. T. R. J.

III.—LEONHARD UND GEINITZ'S NEUES JAHRBUCH. Jahrgang 1872. Hefte 3–6.

THESE four numbers contain, besides several instructive mineralogical and petrographical memoirs, some of which are in continuation of papers enumerated in our last notice of the "Jahrbuch" (see Vol. IX., pp. 560–562), three geological papers of considerable interest. The old schistose rocks of a part of the Erzgebirge, between Blankenstein and Grund, are described by Dr. Mietzsch (pp. 561–572). Interpreted according to the modern theory of metamorphic rocks, these old limestones, clay-slates, siliceous schists, quartzites, and gneiss, are becoming better understood, but call for more labour yet. Dr. Jentzsch (pp. 449–480) treats in detail of the alluvial and diluvial deposits near Dresden, drawing conclusions as to the order of events and successive changes associated with the formation of these loams, sands, and gravels, with their far-derived and "erratic" contents.

Dr. C. W. Gümbel describes (pp. 241–260) and illustrates (plates vi. and vii.) two of the most interesting among the Foraminifera that have ancient fossil representatives and yet exist at the present day.

One of these Dr. Gümbel carefully characterizes as *Nummulina Jurassica*, found in a Jurassic limestone of the zone of *Ammonites tenuilobatus*, especially in the siliceous Sponge-limestone, which in France follows on the marly main *tenuilobatus*-beds, and is there more strongly marked by *Am. dentatus*. His specimens are siliceous, and in considerable numbers from Schaflohe, near Amberg.

The other Foraminifera under notice, and of large size, too, are *Orbitulites præcursor* and *O. circumvulvata*, from the grey limestone, with *Megalodus pumilus* (Rotzo beds), of the Alpine Lias, near Roveredo.

Orbitulites was not previously known to be of older date than the Upper Chalk; and though *Nummulina* is quoted from the Oolite, and even from the Carboniferous Limestone, exact information is still wanting. Dr. Gümbel clears up some obscurities about supposed Cretaceous Nummulites (such as *Alveolina Fraasi*, formerly thought to be a Nummulite), and has thus added much in this branch of palæontology. T. R. J.

REVIEWS

I.—Records of the Rocks, or Notes upon the Geology, Natural History, and Antiquities of North and South Wales, Devon, and Cornwall. By the Rev. W. S. Symonds, F.G.S. 8vo. pp. 434, with numerous Illustrations. (London, 1872: John Murray.)

SINCE Hugh Miller gave to the world his testimony of the Rocks, we have not had a more fascinating book than the "Records of the Rocks," by the Rev. W. S. Symonds. It is the work of a master upon the subject, and one who is well acquainted with the classical regions of England and Wales upon which the "Records" treat. It is indeed almost a complete guide to the natural and physical history and antiquities of the Principality and border counties. The author, as stated in his Preface, has "dealt with some districts to which Murchison hardly alludes, and with subjects that would have been foreign to his purpose."

An interesting description of the igneous rocks occupies the "Introduction," and prepares the reader for the many references in the text to the phenomena and distribution of igneous and volcanic action, so grandly developed in the Cambrian and Silurian rocks of Britain, without some knowledge of which no student can penetrate into the structural mysteries, or understand the grand and varied scenery, of the mountainous regions of Wales. The rock masses of the wonderful regions of Iona, Staffa, the Giant's Causeway, Arthur's Seat, Cader Idris, and Snowdonia, in our own country, Auvergne, the Ardèche, and the regions of Etna and Vesuvius, have no place in the minds of those who know nothing of the chemical condition or constituents and physical structure of the masses composing them. The general reader will find a simple yet good account of the igneous rocks in the author's introduction.

The historical portion of the "Records" commences with the oldest sedimentary rocks on the globe, now termed Laurentian. These ancient deposits constitute a large portion of Canada, West Scotland, and fragments also exist at Malvern and Charnwood, etc. Language only such as that used by the author can convey any idea of the wild scenery of the North-western part of Sutherlandshire and the Hebrides, where "the spectator who ascends to the haunts of the ptarmigan on Queenaig beholds a weird and wonderful scene. He looks upon low masses of rugged gneiss hills, which appear like a rolling sea, its waves frozen hard and fast as they rocked to and fro." To any one knowing the history of these vastly *ancient* rocks of Wales, Malvern, and Scotland, there is a charm in the manner in which Mr. Symonds treats them, and the associated archæological and botanical features render the description classical and unique. We know of no better account of the British Laurentian rocks than that given in the first chapter of the "Records."

The author in his treatment of the Cambrian rocks divides them into two groups, Lower and Upper Cambrian. Great ability and knowledge are displayed in the whole chapter upon the Cambrian and Cambro-Silurian series. The history and description of the Llanberris, Longmynd, and Harlech rocks, which, with the Menevian group, constitute the lower division of the Cambrian series, is written as those only can who have themselves examined the area they occupy. Snatches of history, antiquity, archæology, natural history, and scenery, are so judiciously interwoven with the petrological descriptions and geological aspects of the Cambrian rocks, that one is almost tempted to journey, book in hand as our guide, to explore and examine these mysterious monuments of high antiquity, wherein are entombed the very earliest forms of existence known upon the globe. He who has never seen the Longmynds, the rocks of Harlech, the schists and slate of Barmouth, and Llanberris, with Bardsey and St. David's Head, can little comprehend the early history of the British islands, either physically or palæontologically. It is a feature in the "Records of the Rocks" to create that desire, and with the "Records" in hand, and the maps prepared by the Geological Survey, little else is needed, save note-book and hammer, to enable the student or tourist to read the far past clearly and unmistakably. The author neglects not to associate with the rocks the localities of many of the rare Scandinavian plants; the home of the wild bird; the brooks and tarns, with their rare fish; and carefully he notices and names the fossil fauna in those districts where, without almost direct guidance, the metamorphosed character of the rocks would defy their detection. The seventy-seven pages devoted to the Laurentian and Cambrian rocks and their associated history is the best digest in our language, and is written by one who has a great knowledge and love of nature, and whose life has been devoted to Cambrian and Silurian geology, and the natural history of the area embraced by the "Records."

Chapters iv., v., and vi., comprising 134 pages, are devoted to the Silurian System, or to the Lower, Middle, and Upper Silurian rocks. Mr. Symonds places the Lower Llandeilo (Arenig or Skiddaw rocks of Sedgwick) at the base of the Silurian; the Geological Survey make the Lingula flags their base. It is a pity so many "tops and bottoms" are made to these lower rocks. These diverse views have led to much confusion. It is well, however, that we have a published line, so that in the field at least the horizon is established, modify it how we may in the study. Controversy, however, concerns us not here; neither do the minor differences of authors enter into notice of the "Records." All agree in one thing—that the chaos of the older writers, the "Grauwackians," was reduced to systematic order by Murchison, Sedgwick, and Lewis. To the former, however, must be awarded the high credit of definitely determining and defining the "Silurian system." Few even now realize that great and difficult work. The author of the "Records of the Rocks" is one, however, who has spent his days upon the earliest life rocks that lifted their heads to the sun—the oldest rock masses in the world's history. He has been a Silurian student from boyhood. His analysis of Lower Palæozoic time tells us that he has studied well and diligently, and has mastered and comprehended the scope ıd meaning of the "Silurian chief," and is a fit exponent of his ews and country.

The table at the commencement of the chapter devoted to Silurian ology comprises the author's accepted system, his lowest formation ing the "Lower Llandeilo"; thus throwing the Tremadoc and ingula flags of the Geological Survey and Sir Roderick Murchison to the Upper Cambrian. Sir Roderick in his last edition of luria included all below the Llandeilo series in his "Primordial lurian," not allowing the term Cambrian as then understood. It ust be admitted that even now there is extreme confusion as to e subdivision of the stratified series below the Lingula flags.

The Menevian, Harlech, Longmynd, St. David's, etc., etc., rocks ve yet to be satisfactorily correlated. The Menevian beds are aced by Mr. Symonds as a passage group between the Lower ingula flags and the Harlech grits. The vast accumulation of both uptive and contemporaneous lava flows, as well as volcanic ash posits, define in a most marked manner the commencement of e Lower Llandeilo, or close of the Lingula flag period. These enomena are grandly shown in the great ranges of the Cader, the rans, and the Arenigs, etc., in Wales, and the Skiddaw area in estmoreland, etc., where they are also extensively interbedded or terstratified with the slates and grits of that classical area. The thor's description of the scenery, history, and antiquities of the untry occupied by the Lower Silurian rocks, as well as the cidental notices upon the occurrence and distribution of rare forms the flora and fauna, must be read to be appreciated. They show rare appreciation of the true and the beautiful in nature. The ngular ridge of rocks termed "Stiper stones" by Murchison in is first and great Silurian system are well described, and should made the special object of a journey of inspection over the wild act of the Longmynd Mountain. These grey and buff sandstones long to the Lower Llandeilo period. Annelide tracks and burrows, rtical to the plane of bedding, riddle these ancient sandstones, *renicolites linearis* being the architect of their once submarine perrations and burrows. The author recommends the student who ishes to master the intricate geology of the Longmynd area to end some time at Church Stretton, Bishop's Castle, etc. We have ne so, with pleasure and profit. This once Cambrian island in the lurian seas is even now, geologically and physically speaking, a rrestrial one, surrounded, as the Longmynd is, by unconformable cks of Upper and Lower Silurian age at every point of the compass. he author's description of the Caradoc and Bala rocks over the Snownian, Caradoc, and Cader Idris districts, the Berwyns, the Wrekin, c., reads more like some fairy tale. Every page is full of exact struction, without that severe style characteristic of ordinary manuals pon geology. Chapter v. treats of the Middle Silurian rocks, a ivision not admitted by Sir Roderick Murchison or the Geological urvey. The author, too, has incorporated and placed the Lower landovery rocks at the base of his triple division of the Middle ilurian, the Tarannon shales being the uppermost member. We are not quite prepared to admit or agree with the author in removing the Lower Llandovery out of the Lower Silurian, its affinity with the Caradoc or Bala series being so close both on stratigraphical as well as palæontological grounds. Out of the 560 species known in the Caradoc, and 126 in the Lower Llandovery, ninety-two are common, no less than eighteen species of Corals, thirty-six Brachiopoda, ten Gasteropoda, nine Crustacea, six Cephalopoda, etc., being common to the two formations; only eleven species are really peculiar to the Lower Llandovery rocks. We know of no physical break between the Lower Llandovery and Caradoc, though between it and the Upper there appears to be no doubt whatever.

The reader will do well to carefully read this chapter apart from the abstract question of stratigraphical subdivision. It is admirably and clearly written.

In Chapter vi., 60 pages are devoted to the Upper Silurian Rocks. These pages are really a manual of Upper Silurian Geology and Geography, or Topographical Geology, interspersed with so much general and local history and lore that every class of reader may be interested. The rocks are described in ascending order, their geographical distribution and historical associations being highly instructive. The section devoted to the Wenlock rocks is suggestive, clear, and like the previous chapters, a "vade mecum" to the tourist and Silurian student. The points of interest, and localities where good sections and rich fossil-grounds can be seen, are depicted with a local knowledge possessed by few geologists. The Ledbury rocks and passage-beds are debatable ground where the speculative geologist may revel in disquisition and doubt as to the more minute subdivisions in the upper series. Here too the Ganoid and Placoid fishes for the first time attest their presence in Britain. fragments of many genera (*Pteraspis*, *Auchenaspis*, *Cephalaspis*, *Scaphaspis*) occurring in varied abundance. These Ledbury or passage rocks connect the Upper Ludlow shales with the base of the Old Red Sandstone; and where junction sections are seen, they become of extreme interest. The earliest determined fossil plant-remains in the British Islands come from the passage-beds at Bodenham, west of Ledbury, and may have belonged to the first or earliest Lycopodiaceous plants, the ancestors, indeed, of the Devonian and Carboniferous Lycopods. For most interesting matter upon the Upper Silurian rocks the reader must consult the "Records." Four plates of very characteristic fossils and many woodcuts accompany the Silurian division of the volume.

The Old Red Sandstone Chapter (vii.) adds little, physically, to the hitherto known history and extension of these rocks. The Old Red, however, in Herefordshire and Monmouthshire, in its triple division, is indeed a grand feature. In the Vans of Brecon and Carmarthen, which rise nearly 3000 feet above the sea, their northern flanks and outcrop afford scenery of surpassing boldness and grandeur.

The rapid development of genera and species of the fossil fishes, as well as their classification and distribution through the rocks of the Old Red Sandstone, especially Scotland, has been the theme of Miller, Agassiz, Murchison, and others, and we now subdivide the group into Lower, Middle, and Upper according to the genera of fishes most abundant in these subdivisions. These various points are well discussed in the "Records." Few or no fossils occur in the Old Red proper, save the fishes, and Meristomatous Crustacea, no Mollusca, and few plants. Space forbids more notice of the interesting chapters upon the Old Red Sandstone. Chapter viii., however, contains 44 pages upon the Devonian Rocks of Devon and Cornwall. On p. 260 is given a table of the whole series and its subdivisions in N. Devon, S. Devon, and Cornwall, and the views of various authors are discussed in the fairest manner through the well-written pages of the Devonian History. We are able to appreciate both the original work of the author and his criticisms upon the labours of others—it being our good fortune to have laboured to unravel the intricate physical structure of the grand area under consideration. The author properly places, we think, the unfossiliferous Red grits and sandstone of Pickwell Down or Woolcombe Bay at the base of the Upper Devonian. They form a natural base, and were slowly deposited as the sea-bed became upheaved at the close of the Mid-Devonian deposits. We ask the reader to visit Woolcombe Bay, Baggy Head, Croyde Bay, etc., and he will never doubt the value of the Upper Devonian rocks in stratigraphical geology; more so still, if he will honestly examine the Barnstable, Ven and Coddon Hill Carboniferous rocks above them. The Middle Devonian rocks of South Devon and Cornwall receive their share of comment and discussion. The former are so completely the counterpart of the Eifel District of the Rhenish provinces in every particular that their correlation is absolute, stratigraphically and palæontologically. We must again refer the student and reader to the matter and views of the author upon the Devonian question in his "Records."

Ninety-five pages of most valuable matter are given to the Carboniferous rocks of the West of England and Wales. The author, in his "loves," says, "The mountain limestone is beloved by the Geologist for its picturesque scenery, its caves with their stores of old bones and the number and variety of its fossils; by the Botanist for the rare and beautiful plants nourished in its fissures and on its slopes; by the Archæologist for its cromlechs, old camps, and ancient dykes; and by the Historian for its memories of many a hard battle and many a struggle for independence fought out to the death among its ravines and dingles." Anglesea, the Menai Straits, Great Orm's Head, Denbigh, Clwyd, Chirk, Llangollen, etc., in the north; with Cefn, Tenby, the Cerrigs, the border or rim of the great Welsh Coal-field, Cowbridge, etc., in the south; with numerous well-defined and characteristic areas, receive ample notice of geological interest, geographical distribution, and typical fossil contents of the rocks under notice. The author's description of the limestone of St. Gowan's Head, "Eligug Stacks," etc., its birds, flora, and history, like other descriptive portions of his interesting volume, cannot receive justice at our hands for want of space for quotations; and to those who know as we do the county described, there is an inexpressible charm in thus mentally revisiting districts that recall days spent amidst scenes so wild, and studies so absorbing, here so truthfully rendered. The Wynd Cliff, Tintern, the bone-caves of the Dowards, Raven's Cliff, and other classical localities on the Wye, rendered still more so by the varied knowledge imparted to them by Mr. Symonds, close the chapter upon the Carboniferous Limestone. The Coal-measures receive a separate notice, many of the Coal-fields being briefly described. He who would wish to understand the physical geology of the Coal-measures need only visit the great Coal-field of South Wales, where along its northern escarpment, deep central valleys, or southern outcrops, all the grand features of this great epoch in the history of the British Island can be read and studied as in no other area in Europe.

No record of, or memoir upon the Palæozoic Rocks, would be complete without some notice of the Permian series which closes the history of Palæozoic time. It is enough to say that this chapter, like most others in the "Records," is interestingly and well done. The book is admirably illustrated, 30 woodcuts are given, illustrating both physical structure and picturesque scenes. The accomplished President of the Cotteswold Club, Sir W. V. Guise, Bart., F.L.S., has enriched the "Records" with four exquisite delineations of the "Eligug Stacks" near Pembroke, "Marloes Bay," "The Home of *Draba aizoides*," and "St. Gowan's Chapel, Pembrokeshire." There are also five plates of typical fossils admirably and characteristically drawn by Miss Dora Baker, of Hasfield Court, Gloucestershire. Few of the Sections are original; Professor Ramsay's North Wales and Sir Roderick Murchison's Siluria affording the chief. We hope to see in the next edition a geologically coloured map of Wales, adapted to the text. The volume is the basis of the best and most interesting scientific guide ("Record") ever yet executed to elucidate the intricacies, and causes, and effects of Silurian, Devonian, and Carboniferous topographical geology. R. E.

II.—VALLEYS, DELTAS, BAYS, AND ESTUARIES.

By CHARLES RICKETTS, M.D., F.G.S.

[Presidential Address to the Liverpool Geological Society, 1872.]

REFERRING at first to the subject of Denudation, and to some of the current opinions thereon, Dr. Ricketts observes that although we see the effects of marine denudation most prominently brought before us, yet atmospheric agencies, rain and rivers, have a far larger basis of operation, and wear away much more of our land than the sea; and that although the majority of our geological formations have been deposited beneath the sea, the sediment must not be attributed so much to the erosion of coast-line as to the transporting power of rivers. Treating of the Palæozoic rocks, he remarks that, in looking at a section, whilst many of these formations have commenced n shallow water and near the coast, subsequent accumulations of great thickness prove a subsidence of the land, and the consequent deposition of the succeeding strata further and further away from the shore, even "at a distance of many miles from the coast, so that by no possibility could the sediment have been derived from marine denudation acting on cliffs." With this last argument we cannot entirely agree, as no allowance seems to be made for the dispersion of sediment by marine currents.

Dr. Ricketts reviews some of the principal opinions in regard to the origin of valleys, and advocates their subaërial origin. He refers to the eroding power of ice, and gives his opinion that the subsidence of the land in England during the Glacial period was due "to the combined weight of ice and the Boulder-clay pressing down the surface to below the sea-level; the land being again raised to a considerable extent, when, upon the return of a more genial climate, it was relieved of its load of ice and snow."

Turning his attention to Deltas, he remarks that these accumulations, which attain such a great thickness in many instances, must have been accompanied by a subsidence of the area over which they are deposited, "which is generally gradual and imperceptible, but under certain conditions may occasionally occur suddenly." This depression is, he thinks, dependent upon and caused by the accumulation of sedimentary matter.

These notions put forward by Dr. Ricketts, "that alterations of the level of the surface of the land are in very many cases due to alterations in the amount of pressure, either from accumulations of material on, or from denudation of, the earth's surface," are very suggestive, but we cannot regard them as adequately explaining the facts to which he has alluded. Dr. Dawson, as he remarks, thinks that during the Laurentian period, the accumulation of sediment on the "still thin crust of the earth" weighed down the surface, and caused great masses of the sediment to come within the influence of the heated interior nucleus, and thus extensive metamorphism took place; but this does not help us to explain present movements.

In regard to Bays, which are generally attributed to marine denudation, Dr. Ricketts remarks that with few exceptions they have rivers flowing into them, and appear as if they formed a continuation of the valleys; and when deltas occur, it will require the occurrence of a subsidence of the land, to a greater extent than the valley can be filled up by the sediment brought down by the river. He therefore thinks that in such cases the river systems were formerly greatly extended, receiving as tributaries rivers which now empty themselves into the bays. Estuaries, he also looks upon as the result of a subsidence of the land, by which the river-bed has been depressed below the sea-level, owing to the accumulation of sediment.

In conclusion, Dr. Ricketts points out instances of depression which he thinks may be traced to the pressure of accumulations which have not been dependent on river-action. He refers to the harbours along the coasts of Sussex and Hampshire. At Spithead large accumulations of flinty shingle, gravel, and sand have been formed; and such accumulations extending over a considerable area would, he thinks, "be amply sufficient to account for that depression of the land upon which the existence of these harbours depends."

We have devoted so much space to Dr. Ricketts' views, because, coming from the President of the Liverpool Geological Society, we fancy that more faith might be put in them by some than a careful consideration would warrant. Dr. Ricketts has put forward some ideas which may in certain cases explain, or at any rate help to explain, phenomena; but he has pushed his theory too far. If our crust were so feeble that the accumulation of a delta, a shingle beach, or the ice and droppings of a glacier, could weigh it down gradually, we naturally ask, why is not the whole of the land sinking gradually? And how can elevation be due to denudation of material, when denudation cannot take place until the area has been brought up to within its influences?

We have read Dr. Ricketts' address with much interest; it is written in a very pleasant style, and therefore we are sorry to disagree with his views. H. B. W.

III.—THE FORAMINIFERA FIGURED BY EHRENBERG.

ON THE NOMENCLATURE OF THE FORAMINIFERA. Part XV. By W. K. PARKER, F.R.S., and Prof. T. RUPERT JONES, F.R.S. From the Annals Nat. Hist., ser. 4, vol. ix. and x. 1872.

AMONGST the most enthusiastic observers and voluminous writers on Foraminifera Dr. Ch. G. Ehrenberg stands pre-eminent. From 1838 to the present day his observations have been continuous, and the results have appeared in the Transactions and Proceedings of the Berlin Academy of Sciences, and in his "Mikrogeologie," a magnificent folio volume, published in 1854 under royal patronage. The order of their nomenclatorial and bibliographical work having brought Messrs. Parker and Jones to the earliest of Dr. Ehrenberg's memoirs, they "entered on the somewhat arduous and responsible labour of comparing and identifying as far as possible all the Foraminifera he has so abundantly provided in his successive publications." There seem to have been special difficulties in this undertaking, for, with the highest respect for the veteran naturalist, his critics state that they find "his identifications of Foraminiferal species and marked varieties are often incorrect, both among those of his own gathering, and of them with such as had been figured or mentioned by D'Orbigny; and not merely are there difficulties as to *species*, but his generic groups are often discordant with the names they bear, and sometimes comprise two or more different genera," although the several forms are "often grouped naturally on his plates." The figures, perfectly engraved and showing exact and conscientious artistic labour, are drawn from specimens in turpentine or Canada balsam, and seen by transmitted light, with little or no perspective; and yet so truthful are they, that a wide knowledge of similarly mounted Foraminifera enables the rhizopodist to use them as "a storehouse of beautifully prepared specimens." The chief groups of Foraminifera figured in the "Mikrogeologie" are Tertiary and Cretaceous, from different parts of the world. The plates illustrative of specimens from the Chalk of Meudon (pl. xxvii.) and of Gravesend (pl. xxviii.) have already been described in the GEOL. MAG., Vol. VIII., pp. 511 and 563. The figures of some Palæozoic Foraminifera, from the Carboniferous strata of Russia, chiefly *Fusulina* (several species) and *Endothyra*, are also elucidated by our authors. *Endothyra sphæroidea* (Ehr.) in the Oolite; *Operculina turgida* (Ehr.) in the Chalk of Russia; and *Amphistegina* and *Orbitoides*, fossil in Java; are amongst the more interesting facts. A classified list of the fossil Foraminifera figured by Ehrenberg, and a list of his generic names and their probable equivalents, form Appendices to the paper under notice, the object of which is thus stated by Messrs. Parker and Jones:—"We feel certain that the better Ehrenberg's work is understood, his beautiful and lasting illustrations, and his painstaking synoptical registers, will largely advance the progress of biology in its relation to both the present and the past. In removing some obscurity from the highly valuable groups of Foraminifera of which he has treated, we feel the pleasure of being of use to naturalists and geologists, enabling them to put several extensive faunæ and local groups into close critical relation with each other, and with such as have been observed by others. Further, we are sure that Ehrenberg himself, thinking over the improved biological systems of later naturalists, and open to conviction on good arguments, would freshly recognize the force of his own words respecting the importance of rhizopodal studies and their slowly progressive nature; and be pleased to find, also, his own researches not only serving as a broad basis for the study in general and as steps to higher knowledge, but still more freely trodden in the upward ascent, when made somewhat clearer and firmer for the student."

REPORTS AND PROCEEDINGS.

GEOLOGICAL SOCIETY OF LONDON.—December 18, 1872.—Warington W. Smyth, Esq., F.R.S., Vice-President, in the Chair.—The following communications were read:—1. "Further Notes on the Punfield Section." By C. J. A. Meÿer, Esq., F.G.S.

This paper was supplementary to one read before the Society by the author in March of the present year (see Quart. Journ. Geol. Soc. xxviii. p. 245), and contained the results of a fresh examination of the section at Punfield, and of the Wealden and Neocomian strata of the Isle of Wight. He described the section exposed at his visit to Punfield as presenting:—1. True Wealden beds; 2. a grit-bed with limestone and paper-shales, containing fish-bones and Cyprides; 3. apparently argillaceous beds; 4. a thin band of hard ferruginous sandstone with Atherfield fossils; 5. a clay-bed, the upper part regarded as representing the "Lobster Clay" of Atherfield, the lower sandy portion containing an abundance of marine fossils belonging to common Atherfield species; 6. the so-called "marine band;" and 7. laminated clays and sands with lignite. The author indicated the accordance of this arrangement with what is observed elsewhere, and maintained that the grit-bed (No. 2), with its limestone and paper-shales, containing *Cypris* and *Cyrena*, was really to be regarded as the passage-bed between the Wealden and the Neocomian.

Discussion.—Mr. Judd congratulated the author on the interesting nature of his discoveries, which in his opinion bore out most completely his own views and those of others who had worked before him in the same field. He cited Dr. Fitton, Mr. Godwin-Austen, and Sir Charles Lyell as regarding the beds as unquestionably Wealden, though with some marine bands accidentally intermingled. Prof. Ed. Forbes, Prof. Phillips, and the Geological Survey had also regarded these beds as Wealden, notwithstanding the temptation there existed from stratigraphical reasons to place them in the Lower Greensand. These authors had supported their views of the Wealden nature of these beds by collections of freshwater fossils, some of which were figured, and are still preserved in public collections. He had himself regarded the Punfield series as Neocomian, though still closely connected with the Wealden, and, in fact, forming a transitional series of beds between the two, though absolutely belonging to neither, and therefore worthy of a distinctive name. He accepted the author's view, as carrying the boundary of these transitional beds to a lower level than that previously assigned to them. In correlating the Punfield beds with those of the Isle of Wight, he disputed the value of the evidence of the lobster-beds, which, as had been pointed out by Edward Forbes, must of necessity have varied in character at points any considerable distance apart.

Mr. Seeley had regarded the Punfield beds from the same point of view as Mr. Meyer, and had all along felt objections to the opinion of Mr. Judd. This had been partly the result of his observations of the section, partly the result of the palæontological evidence. By following the beds westward he had arrived nearer the source of the materials of which they were composed, and had noted more particularly a certain grit-bed which he thought could be recognized through the whole series, and therefore afforded a sort of basis for argument. The beds thinned out to the west and thickened to the east. He was prepared to accept the two lobster-beds, which in the section were one over the other, as merely showing the persistence of the same bed, which, though continuous, had changed its position during the interval.

Prof. T. Rupert Jones considered that certain beds in the Wealden were susceptible of correlation over very wide areas by means of certain brecciated beds. He pointed out that near Pulborough and at other places the Wealden terminated in paper-shales, the same as those which Mr. Meyer had placed at the top of the series at Punfield. Above these he thought no purely freshwater beds were to be found. He considered that the whole, including the Wealden, were included in the Neocomian.

Mr. Etheridge thought the difference between the various writers on this subject to be mainly one of terms. The same fossils as those found at Punfield had been found in abundance in Spain.

Mr. Meyer maintained, in opposition to Mr. Judd, that the Punfield beds were not merely Upper Wealden. He had found a certain form of *Ostrea* over large areas always on the same horizon; and this had occurred at Punfield at precisely the level at which, in accordance with his views, it ought to have been present. Above the marine bands he had sought in vain for fossils.

2. "On the Coprolites of the Upper Greensand Formation, and on Flints." By W. Johnson Sollas, Esq. Communicated by the Rev. T. G. Bonney, M.A., F.G.S.

The first part of this paper was principally occupied in an endeavour to explain the perfect fossilization of sponges and other soft-bodied animals. It was shown that the hypothesis which considered that sponges had become silicified by an attraction of their spicules for silica was altogether untenable. Mr. H. Johnson's supposititious reaction, according to which the carbon of animal matter is directly replaced by silicon, was shown to be inconsistent with the known facts of chemistry. The author's explanation was not intended to be final. The first fact pointed out was the very remarkable way in which the silica or calcic phosphate of the fossils under consideration followed the former extension of organic matter. This was explained for silica by the fact that, when silicic acid is added to such animal matters as albumen or gelatin, it forms with them a definite chemical compound; and it was assumed that in process of time this highly complex organic substance would decompose, its organic constituents would be evolved, and its silica would remain behind. In such a way flints might be produced, and dialysis would lend its aid. The same explanation was applied to account for the connexion between calcic phosphate and animal matter in the case of the "Coprolites."

The Blackdown silicified shells were next explained, and it was reasoned that the state of their silica offered arguments tending to prove a passage of silica from the colloidal to the crystalline state.

The second part of the paper discussed the Coprolites specially; their exterior appearance is extremely sponge-like, almost exactly resembling some species of modern sponges. They are marked by oscules of peculiar characters.

The so-called "pores" of palæontologists are well marked. Spicules, triradiate, hexradiate, sinuous, defensive and connecting, have been observed. They are siliceous in composition. On dissolving the coprolites in acid, the spicules are set free, associated with *Polycystina* (*Haliomma hexacantha*, etc.) and *Xanthidia* (*N. furcatum*). The genera and species of coprolites described were as follows:—*Rhabdospongia communis*, *Bonneyia bacilliformis*, *B. cylindricus*, *B. Jessoni*, *B. scrobiculatus*, *B. verrongiformis*, *Acanthophora Hartogii*, *Polycantha Etheridgii*, *Retia simplex*, *R. costata*, *Ulospongia patera*, *U. calyx*, *U. Brunii*. The external appearance of these forms, which constitute a great number of the coprolites, their curious oscules and siliceous spicules, were said to leave no doubt as to their spongious origin.

Discussion.—Mr. Charlesworth complained that the author had not fully stated Dr. Bowerbank's views, which were founded on the fact that flint, wherever found, whether in fissures, the interior of organisms, or elsewhere, always presented under the microscope a reticulated structure. He had himself combated the view that flint was in all cases silicified sponge, and had demonstrated that certainly, in some cases, flint had been formed without the intervention of sponges; for in the case of the teeth in a lower jaw of a *Mosasaurus* found in the chalk, he had found the pulp-cavities completely filled with black flint. At the same time the bone and dentine had remained unsilicified. Even in this flint, however, Dr. Bowerbank thought he had recognized spongy texture, and accounted for the presence of sponge in so singular a position in what seemed to be by no means a satisfactory manner. Mr. Charlesworth maintained that siliceous matter did not always follow organic fibre, and that in the case of most Ventriculites the flint never embraced the whole of the organism. In the chalk of the southern parts of England, the roots and upper portion of Ventriculites were hardly ever to his knowledge completely silicified. In Yorkshire, on the contrary, the whole body of the sponge was silicified, and flint was but rarely found of other forms. He called attention to the fact that when a shell, such as that of an Echinoderm, was completely filled and enveloped by flint, it remained in the state of carbonate of lime; where only filled but not enveloped, a portion of the shell had been replaced by silica.

Prof. T. Rupert Jones regretted that observations in this country were principally confined to the flints of our Southern Chalk. He had himself never seen such silicified shells of Echinoderms as those described by Mr. Charlesworth. He considered that in many cases the flint was, in fact, pseudomorphous silica after amorphous carbonate of lime, and that there was a gradual change from carbonate of lime into silica taking place, so that the theory of the author was not in all cases applicable.

Rev. O. Fisher was not prepared to accept the whole of the coprolites as having been originally sponges, nor as having been derived from the Gault. He thought, on the contrary, that they came out of a chloritic marl which was not truly Upper Greensand.

Mr. Carruthers thought that the speculations in the first part of the paper, though interesting, formed only a portion of a very large subject; and he would be glad to see the considerations extended to the fossilization by silica of other bodies than sponges. He thought in most instances the silicification was the result of what took place long after the organisms had been imbedded in the rock.

Mr. Gwyn Jeffreys stated that in deep-sea explorations he had found both siliceous and calcareous sponges in the same area. He had taken them both alive and dead, and in no case was there silicification. In the case of foraminifera he had, however, found the interior filled with silica.

Mr. Johnson stated that he had not confined his remarks in the paper cited by the author to the substitution of silicon for carbon, but had instanced that as only one of the steps towards silicification.

Mr. Evans mentioned the late M. Meillet, of Poitiers, as having some years since pointed out the cause of the whitening of flint by age.

Mr. Woodward pointed out that the condition of most silicified Ventriculites seems to afford evidence that the process had gone on at a period long subsequent to their imbedding in the Chalk.

Prof. Williamson commented on the difficulties of the case, and said he believed that in most fossils more than one process had conduced to the result. He agreed with Mr. Charlesworth as to the character of the Yorkshire fossil sponges, in which the silica had most completely replaced the keratose fibres. By the action of acid it was possible to obtain their skeletons as perfect as those of living species. There had been no mere infiltration in the case, but a real chemical union between the silica and the keratose fibres. At Flamborough Head, close by silicified sponges, he had found others in which the organic matter had been entirely replaced by oxide of iron instead of silica; and these, on being treated with acid, were dissolved. In the case of the foraminifera, three distinct agencies had taken place,—one an infiltration, another the conversion of animal matter into flint, and the third that of calcareous matter into flint also.

Mr. Sollas, in reply, pointed out that he had not stated that flint was formed by the silicification of sponge-tissue, but by that of animal matter. He did not think that any mere mineral change could account for the forms of flints. He had only dealt with a limited portion of the question of the origin of flint and coprolites. Of the organic origin of the latter there could be no doubt. He thought that the non-silicified condition of recent dead sponges might be due to a defective supply of silica in the sea-water. He had not put so much stress on dialysis as had been supposed, but relied mainly on the deposition of flint by means of organic matter. From the presence of *siliceous* spicules of peculiar forms in the coprolites, he could not accept them as of Alcyonarian origin.

GEOLOGISTS' ASSOCIATION—January 3, 1873.—The Rev. T. Wiltshire, M.A., F.G.S., President, in the Chair. — "On the Cambrian and Silurian Rocks of Ramsay Island, St. David's," by Henry Hicks, Esq., F.G.S.

In an exposed coast section which occurs at the north end of Ramsay Island, the three important groups of strata known under the names Lingula Flags, Tremadoc, and Arenig Groups, are seen resting on one another in the order of their succession, and probably are better exhibited than at any other place in Wales. The first two groups are those now usually recognized as forming the upper part of the Cambrian; and the latter as the lowest group of the Silurian system. This section is therefore of considerable importance, in its bearing on classification, as it shows clearly the relation of the groups to each other. The Lingula Flags occur as hard siliceous sandstones with grey flaky slates, and dip under the others at an angle of about 60 degrees. They contain the usual shell, *Lingulella Davisii*, in great abundance; also a Trilobite of the genus *Neseuretus*, *Eophyton*, a supposed land-plant, and numerous worm tracks. The beds are frequently ripple-marked, and give indications of having been shore or shallow water accumulations. The Tremadoc group rests quite conformably on the Lingula Flags, and at first the beds are much like those of the latter in their lithological characters, but afterwards they gradually assume a darker and more flaggy appearance. Fossils are very plentiful in these beds, and numerous new forms come in. Amongst these may be mentioned the Lamellibranchs, Star-fishes, and Encrinites. The Trilobites belong to the genera *Niobe* and *Neseuretus*. A gentle and gradual depression of the sea-bottom was evidently taking place during the deposition of this group. Resting upon the last mentioned is the Arenig group, a series of black iron-stained slates and flags, and with a fauna wholly distinct from that of the Tremadoc group. The Graptolites come in here for the first time, as well as the genera *Æglina*, *Trinucleus*, and *Ogygia*. In many respects the fauna resembles that of the Quebec group of Canada. For the deposition of these beds a deep and decided depression of the sea-bottom must have taken place, and if the succession here is unbroken this must have been sudden. It is probable, however, that a fault has passed along the strike of the beds, and that this has removed the series which should have intervened to connect them more closely, lithologically, and palæontologically. As far as can be made out by this section, the boundary line between Cambrian and Silurian should be certainly placed *above* the Tremadoc group as exhibited at St. David's (the upper part of the Tremadoc group of North Wales will doubtless have to be included in the Arenig group), and *below* the Arenig group.

CORRESPONDENCE.

THE SETTLE CAVE DEPOSITS.

SIR,—Mr. Tiddeman's description of the older deposits in the Victoria Cave at Settle encourages me to ask him through your pages kindly to consider whether the laminated glacial clay that he has so well made out, as occurring between the upper cave earth and the bone-bed with the older cave mammals, may not be an indication of that last glacial period which I have so often advocated in your pages; but without the success in drawing attention to the subject which I could wish.[1]

It is plain from Mr. Tiddeman's paper, "On the Ice-sheet in North Lancashire," that the term which I gave to the moraine profonde of that particular period, viz. "Trail," has reached his ears; but I doubt if he has read my papers: otherwise he would not have applied the term to "a subaerial drag" or "trail" of soft beds to a lower level, under the softening and loosening influences of rain and frost,[2] and argued for a glacial origin of a phenomenon which I have always maintained *has* that origin.

The particular reason which induces me to suspect that the laminated clay of the Settle Cave belongs to the period of *the* "Trail" is because it occupies the right position in time, as being subsequent to the Cave Mammals. I have shown that that deposit is none other than the river gravels, which contain the same fauna as the caves. I must confess that I do not quite understand what date Mr. Tiddeman assigns to the ice-sheet which he has described. I have not had time to read his paper in the Journal so carefully as I could wish, but I perceive that in that paper, as well as in the MAGAZINE, he uses the expression, "*The* Glacial Period." One is inclined to ask, "Which?" There is a remarkable passage in Mr. Dawkins's paper on the "Classification of Pleistocene Strata," which strongly in my opinion supports my view of this late ice-sheet, and also that the laminated clay of the Settle cave belongs to it. It is that in which he insists on the magnitude of the interval between the late Pleistocene and the Prehistoric ages in Britain, during which nineteen species disappeared, and five at least became extinct.[3]

HARLTON RECTORY, NEAR CAMBRIDGE. O. FISHER.

OBITUARY.

BY the death of Mr. JOHN BOLTON, of Sedgwick Cottage, Swarthmoor, near Ulverstone, the geology of Furness has sustained a great loss, and palæontology a most enthusiastic collector. His passion for fossils originated in 1795, when a child of seven years old, from sauntering, near an excavation for a well in the Mountain Limestone of Urswick Green, where he observed and obtained the stems and separate joints of Encrinites, the "fairy cheeses" and "queer things" of his playfellows. From this date his interest in Nature never seems to have flagged, notwithstanding that he was two years later sent to a weaving-shed in Ulverstone, and afterwards to Barnsley, where he effected an important improvement in the Jacquard loom, of which he allowed others to reap the benefit. Returning to his native district of Furness, he practised as a land-surveyor, and devoted days and weeks for more than half a century in examining well nigh every square yard of Furness and the adjacent Lake-Mountains, and collecting the fossils from the Skiddaw slates, in some of the wildest and least frequented mountain peaks and secluded ghylls in North Britain. In 1862 a paper of his was communicated to the Geological Society of London, "On a Deposit, with Insects, Leaves, etc., near Ulverstone," in which he described several points connected with the deposition of hæmatite, a subject in which he had obtained much experience. In 1869 he published his work on the Geology of Furness, entitled "Geological Fragments," in which he describes his chief fossil discoveries, and gives an interesting and *naïve* account of his adventures among the mountains with the dalesmen of the North, and of his intercourse with Prof. Sedgwick, and other veteran geologists, who first worked out the geology of the Lake District. In this work John Bolton must always be considered to have had some share, in having collected the fossils of Furness before a single geologist had ever visited that country, and from having, during a long life, probably obtained more fossils from the Lake District than any other person.

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[1] GEOL. MAG., Vol. III. p. 483; Vol. IV. p. 194; Vol. VIII. p. 65, etc., etc.

[2] Journal of Geol. Soc. vol. xxviii. pp. 480, 482.

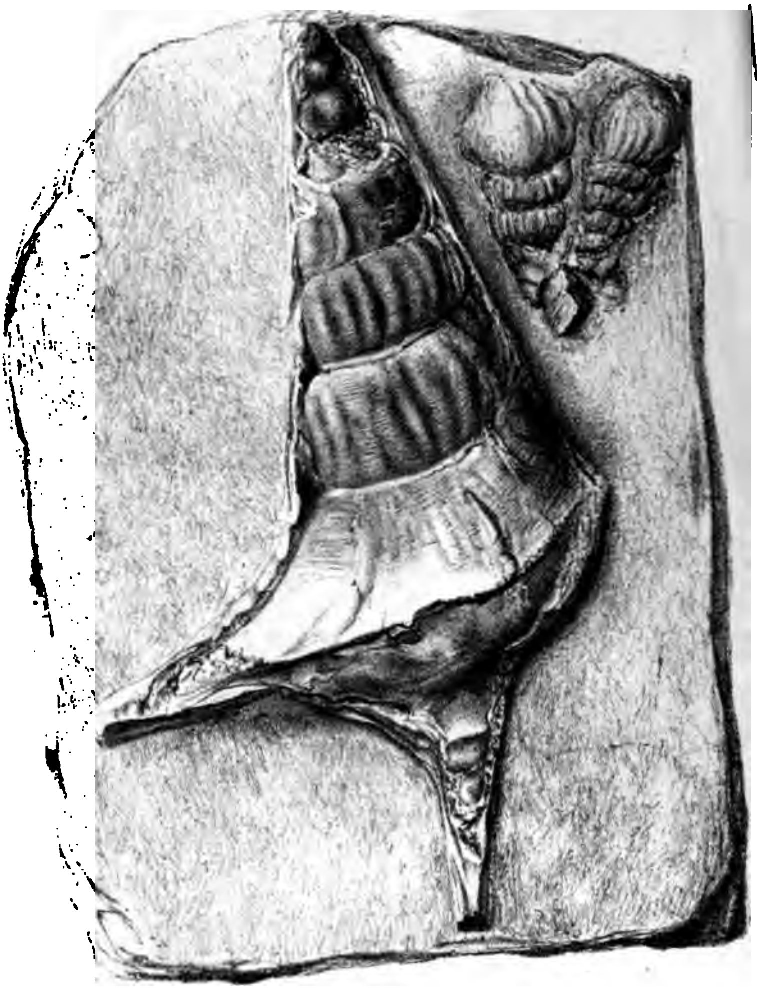
[3] Geol. Journ. vol. xxviii. *p. 414.*

PROFESSOR SEDGWICK, BORN 1786, DIED 1873.

It is with much regret that we record the death of another veteran belonging to the heroic age of Geological science. The Rev. Professor Adam Sedgwick, Fellow of Trinity College, Cambridge, who since 1818 has held the Chair of Woodwardian Professor of Geology in that University, died early on the 27th January, in his 88th year.

The labour of his life was the promotion of Geological science; his happiness, to do good to all around him. His portrait, with an account of his scientific career and published works, will be found in the Geological Magazine for 1870, Vol. VII. p. 145.

Reliquiæ Aquitanicæ.—The publication of this serial work descriptive of the implements, bones, etc., found by MM. Henry Christy and Edouard Lartet in the Caves of the Vezère (Dordogne), France, met with a sad and unexpected interruption from the death of M. Lartet and the troubles of the French war. The lamented M. Lartet had in 1865 cheerfully undertaken the labour of fulfilling all that, from the loss of his friend and fellow-worker, H. Christy had fallen upon him to do, in carrying out as far as possible the original intentions regarding the "Reliquiæ Aquitanicæ." Conscientiously and with loving care he fulfilled this melancholy but congenial task, though much interrupted by ill health and family affliction; until, seriously invalided, and deeply affected by the disasters of his country, he retired from Paris in the dismal autumn of 1870, and was struck by apoplexy at his country residence at Seissan (Gers), January 28, 1871. The executors and friends of the late Henry Christy are desirous of speedily and worthily completing the "Reliquiæ Aquitanicæ" in accordance with the intentions of the authors; and with the aid of friends at home, and of M. Louis Lartet, M. Alphonse Milne-Edwards, M. Sauvage, and other fellow-workers in France, they will proceed with the work as expeditiously as possible. Owing to the melancholy events above *referred to, there will* be fewer Parts published than originally contemplated. *Part XI. is in the press*, and will soon appear.



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D. Blair del. et lith

Rostellaria maxima Price (nat. Size)
Gault Folkestone.

THE
GEOLOGICAL MAGAZINE.

No. CV.—MARCH, 1873.

ORIGINAL ARTICLES.

I.—On a New Species of Rostellaria from the Gault.

By F. G. H. Price, F.G.S., etc.

(PLATE VI.)

I HAVE much pleasure in calling attention to an unusually large Gasteropod, which I had the good fortune to find last February near Copt Point, Folkestone, when in company with Mr. Griffiths, the well-known collector.

It occurred in the Upper Gault, a few feet above the hard seam containing *Inoceramus sulcatus*, and an hybrid *Inoceramus*, in the zone (No. II.) of *Ammonites circularis* and *Kingœna lima* of De Rance.[1]

Never having met with so large a specimen in either of the National Collections or in any private cabinet, I took the opportunity of showing it to Mr. Etheridge, F.R.S., the Rev. Thomas Wiltshire, M.A., F.G.S., and to Mr. J. S. Gardner, F.G.S., all of whom are well known as being thoroughly acquainted with the Gault; but none of them had ever seen so large an example of *Rostellaria* before.

Mr. Wiltshire said that so many exaggerated forms occurred in the bed from whence this specimen was derived, that he was inclined to consider it to be a giant form of *Rostellaria carinata;* but I have carefully compared it with several specimens of *Rostellaria carinata,* and firmly believe it to be a new species.

The following is the description of the fossil:—Shell turreted, having eights whorls flattened and slightly convex with undulate longitudinal costæ, which are crossed by numerous transverse lines. Body-whorl carinated and extended into one spine on the outer lip; sutures distinct, transversely striated. Few or no undulating costæ on the body-whorl above the carina; both above and below the carina the body-whorl is concentrically and delicately striated. The body-whorl is twice the length of the preceding whorl; whorls twice as wide as high. Canal produced. Axis 4¾ inches.

This description may be somewhat similar to that of *Rostellaria carinata*, Mantell, *Apporrhais carinata*, Pictet and Campiche; yet upon close scrutiny it will be readily observed that this specimen is fully twice the size of the largest *Rostellaria* yet known from the Gault.

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[1] See Geol. Mag. Vol. V., No. 4, April, 1868. On the Albian, or Gault of Folkestone, by C. E. De Rance, F.G.S., *of the Geological Survey.*

In my opinion, as well as that of many of my geological friends who have done me the honour of examining this fossil, it is quite a new species, and as such I propose to name it *Rostellaria maxima*, that being the most appropriate designation I can apply to it.

II.—NOTE ON THE SILICIFIED WOODS OF CALIFORNIA.

By J. ARTHUR PHILLIPS, M.Inst.C.E., F.G.S., F.C.S.

THE deep *placers* of California are often covered by a thick capping of lava; in other places, the eruptive matter overlying the auriferous gravels occurs in the form of columnar basalt, beneath which is found the auriferous strata of sand, clay, and gravel. These deposits often contain immense numbers of large tree-trunks, which, with those portions of their branches which remain, are either silicified, or are converted into a lignite, often containing a considerable amount of iron pyrites.

Many of these trees bear unmistakable marks of having been exposed to the action of violent currents before becoming embedded in the detritus which now covers them, and fragments are sometimes met with, of which one portion had become more or less completely converted into lignite previously to silicification. In such cases, specimens may be obtained having the appearance of jet and opal respectively; each portion distinctly retaining the original structure of the wood.

In these sedimentary deposits, leaf-beds and impressions of leaves are of not unfrequent occurrence, and from a preliminary examination of these, by Dr. Newberry, they are believed to be of Tertiary age; probably belonging to the later Pliocene epoch.[1]

In order to determine the difference in composition existing between silicified wood and silicified lignite, the following analyses were made :—

	Silicified Wood, sp. gr. 2·04.		Silicified lignite, sp. gr. 1·95.	
	I.	II.	I.	II.
Silica	92·43	92·26	80·04	79·82
Alumina	trace	trace	trace	trace
Ferrous Oxide	·90	·88	·92	·87
Lime	·12	·18	·16	·16
Potassa	·41	·37	·37	·30
Soda	·20	·18	·20	·22
Carbonaceous matter	...	...	14·06	13·92
Water { Combined	1·87	1·90	1·49	1·54
Water { Hygroscopic	3 90	3·90	2·92	2·92
	99·83	99·67	100·16	99·75

Both specimens were obtained from the trunk of the same tree, found in the auriferous drift under a volcanic capping, near Nevada

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[1] *Geological Survey of California*, pp. 260-261.

City, and have been in my collection since 1866. The transition from silicified wood to silicified lignite was exceedingly gradual, one end of the log being black with a somewhat hackly fracture, while the colour of the other end was yellowish-white, and its fracture conchoidal; both distinctly retained their original woody structure.

These results of analysis show that although every trace of organic matter has disappeared in the silicified wood, the silicified lignite, produced from the same tree, still retains about 14 per cent. of carbon.

It will likewise be observed that if, in the second analysis, abstraction be made of the carbonaceous matter, and the per-centages be re-calculated, they will very nearly agree with those of the silicified wood.

In both analyses the amount of potassa found is greater than that of soda.

III.—The Coal Area of the United States of America.

By C. H. Hitchcock, Hanover, N.H., U.S.A.

In compiling for the Census Bureau of the United States a small geological map, I had occasion to determine the precise areas occupied by workable beds of Carboniferous Coal. As the sum total is different from that recently stated in the Geological Magazine,[1] I have thought a correction desirable; and present a few statements, based upon original authorities, the best within my reach.

There are eight distinct areas of the Coal Measures in the United States. They are—1. The New England Basin. 2. The Pennsylvania Anthracite. 3. The Appalachian Basin. 4. The Michigan Basin. 5. The Illinois Basin. 6. The Missouri Basin. 7. The Texas Basin. 8. Areas of unknown extent, probably inconsiderable, in the Rocky Mountain Region.

1. *New England Basin.*—This is in Massachusetts and Rhode Island, estimated to cover 750 square miles. The coal is a plumbaginous anthracite, used to advantage in some smelting furnaces. Perhaps eleven beds exist, best seen in Portsmouth, R.I. Their maximum thickness is 23 ft. The Coal Measures are about 2,500 feet thick.[2]

2. *Pennsylvania Anthracite.*—This is the most important coal district in the United States. Including the Broad Top semi-anthracite, of 24 square miles, the five separate basins amount to 434 square miles. The Measures are from 2,000 to 3,000 feet thick. The number of distinct beds varies from two to twenty-five, according to the depth of the basin. The maximum thickness at Pottsville is 207 feet, while the average cannot be far from 70 feet.[3]

3. *Appalachian Basin.*—This occupies an area of 63,475 square miles, extending from Pennsylvania to Alabama, all of bituminous coal.

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[1] Geol. Mag., Vol. IX., p. 236. Said to be 100,528 square miles.

[2] Geology of Island of Aquidneck, by C. H. Hitchcock. Proc. Amer. Ass. Adv. Sci., 1860.

[3] *Geology of Pennsylvania, by H. P. Rogers.*

In Pennsylvania the area amounts to 12,222 square miles, with an average thickness of 40 feet of coal. The aggregate thickness of the Measures varies from 825 to 2,535 feet.[1]

In Maryland the area is 550 square miles, in three separate basins. The strata are 1,500 feet thick. There are thirty-two beds of coal, one of fourteen feet, three of six feet each, and the others from one to five feet.[2]

In West Virginia (with a little in Virginia) the coal area occupies 16,000 square miles. On the Kanawha River the strata are 1,250 feet thick, with twenty-four beds of coal, of which eleven have an aggregate thickness of 51 feet. The coals are best developed along this river.[3]

In Ohio Dr. J. S. Newberry mentions that the area is greater than 10,000 square miles, with a thickness of 1,500 feet of sediment, and ten workable beds of coal.

In Eastern Kentucky the area is stated to be 10,000 square miles.[1]

In Tennessee the area of the Measures is 5,100 square miles. A characteristic section gives a thickness of 578 feet. There are seven beds of coal, with a total thickness of 14 feet. The beds vary locally in their dimensions, more than has been reported elsewhere; perhaps because more carefully explored.[4] The conviction is increasing among American geologists that coal beds are not evenly persistent on large areas, and constantly vary in thickness.

In Georgia the area cannot be more than 170 square miles.

In Alabama, a hasty measurement of a map furnished in manuscript by Professor Safford indicates an area of 9,000 square miles. The general character of the Measures must be like those of Tennessee.

4. *The Michigan Basin.*—The area is about 6,700 square miles, with 123 feet thickness of Measures, and eleven feet (maximum) of coal. In the centre the coal is thickest, thinning out to a mere line around the edges.[5]

5. *The Illinois Basin.*—This occupies an area of 51,700 square miles, including Illinois, Indiana, and Western Kentucky.

In Illinois the Measures occupy an area of 41,500 square miles, are from 600 to 2,500 feet thick, and contain ten beds of coal, with an aggregate thickness of 35 feet.[6]

In Indiana the Measures occupy an area of 6,500 square miles, are 650 feet thick, and contain thirteen beds of coal, with an aggregate thickness of 31 feet.[7]

In Western Kentucky[7] the Measures are 612 feet thick, including the Millstone-grit. They contain eleven beds of coal.

6. *The Missouri Basin.*—This is the largest of all the areas, com-

[1] Geology of Pennsylvania, by H. P. Rogers.

[2] First Report upon the Geology of Maryland, by P. T. Tyson.

[3] Report to Chesapeake and Ohio R.R., by T. S. Ridgway.

[4] Geology of Tennessee, by James M. Safford.

[5] Geology of Michigan, 1861, by A. Winchell.

[6] *Final Report* on the Geology of Illinois, by A. H. Worthen.

[7] *Second Report* on the Geology of Indiana, by E. T. Cox.

prising more than 100,000 square miles. It is also reached by everal navigable rivers. It extends from Iowa to Texas. It is eparated from the Texas field only by Cretaceous beds, which probably overlie coal beds continuous from one basin to the other.

In Iowa,[1] Professor White's late map shows an area of about 25,000 square miles of Coal Measures. He has divided the group nto three divisions, each about 200 feet. The two lower ones contain the workable coal, which amounts to eight feet in the second, and only twenty inches in the upper division. As the lower divisions everywhere pass under the higher, the whole area may be regarded as productive.

Nebraska contains 3,600 square miles of the Upper Coal Measures, according to map in Final Report upon the Geology of Nebraska, by F. V. Hayden.

In Missouri (private communication) Professor G. C. Swallow estimates the coal area at 27,000 square miles, and in Kansas at 17,000 square miles. The Measures are 2,000 feet thick, carrying twenty coal beds, from a few inches to six feet thick.

In Arkansas, Dr. D. D. Owen[2] describes two coal beds, the thickest five feet thick, and very valuable. The area is stated to be 12,000 square miles. This coal, however, underlies the conglomerate, and does not belong to the true Coal Measures.

Scarcely anything is known of the coal in Indian territory. From the map, the area must be as great as that of Arkansas. I am assured by the officers of the Missouri, Kansas, and Texas Railway, that they find good beds of coal all through the territory near their line of travel.

7. *The Texas Basin.*—This is barely separable from the preceding. Dr. B. F. Shumard[3] estimated the coal area at 5000 square miles. A. B. Roessler[4] estimates the same at 6000 square miles. Beds of good coal are reported at Fort Bilknop, four feet in thickness.

8. Mr. G. K. Gilbert,[5] of the expedition under the immediate direction of Lieut. George M. Wheeler, reports coal near Camp Apache, in Arizona. Carboniferous strata are known in many places in the mountainous territories, and valuable discoveries of coal may be looked for among them at no distant day.

The total coal area as thus described amounts to 230,659 square miles. No notice is taken of any coals which do not belong to the Carboniferous system. There are many others of commercial importance, as the Triassic of Virginia, the Cretaceous of the Territories west of the Missouri River, an immense amount in California, Alaska, etc.

These facts will afford data for those who are interested in estimating the amount of coal in different countries by the number of cubic miles or tons. The statements are too brief to permit any notice of the best or of the inferior coal.

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[1] Geology of Iowa, by C. A. White.

[2] Second Report, Geology of Arkansas, by D. D. Owen.

[3] Texas Almanac for 1861. [4] Ditto, for 1872. [5] Official Report.

IV.—NOTES ON STAUROLITE, IN CONNEXION WITH METAMORPHISM.

By G. A. LEBOUR, F.G.S.,
of the Geological Survey.

IN the December Number of the GEOLOGICAL MAGAZINE there is an abstract of a most interesting paper published in the "Jahrbuch für Mineralogie," etc., of Leonhard and Geinitz, by C. W. C. Fuchs, entitled, "The Geological, Microscopical, and Chemical Examination of the old Sedimentary Formations in the French Pyrenees, with especial reference to the Metamorphosis of these and other old Rocks." In this paper attention is called to the manner in which the degree of metamorphism of clay-schists and other rocks is sometimes indicated by the formation and gradual development of certain minerals, Andalusite and Chiastolite being those specially mentioned.

Quoting from the abstract given (GEOL. MAG., Vol. IX. p. 562), conclusions Nos. 4 and 5 arrived at by Fuchs stand thus: "4. This [metamorphism] commences with the separation of small nodules in the clay-schist, which gradually [*i.e.* as we approach some adjacent granite] increase in number and size, and at last become Andalusite and Chiastolite. During the development of these minerals, the rest of the rock changes bit by bit into a confused mass of mica and quartz, with some felspar. 5. Lastly, real mica-schist and gneiss are produced."

Without entering into the purely chemical portion of this subject, with which I could not attempt to deal, I think it may be worth while to place on record a few facts which have for some years been known to me, and which appear to bear out in a striking manner the views just adverted to.

In the Departments of Finistère and Morbihan it is well known to tourists that on certain Pardon days, in some parishes, a brisk trade is driven by retailers of religious ornaments in cruciform black stones, variously known as "Pierres de croix" or "Pierres de Coadry." These are simply good specimens of twin crystals of Staurolite, but the cross-merchants preserve a judicious silence as to the localities whence they procure them. All that one can usually arrive at on the subject is that they come from *somewhere* near Coadry in Finistère, or near Lhominé in Morbihan. In 1868, not being satisfied with this scanty information, I made a minute and successful search for the cross-stones in both places. The results were the same in each case, and were as follows, taking the Coadry locality only, the description being equally applicable, for the purpose in hand, to it and to Lhominé.

The geology of the part of Western Brittany in which the little hamlet of Coadry is situated, namely, some eight or nine miles due north of Bannalec, between Rosporden and Quimperlé, consists chiefly of broad tracts of clay- and mica-schists abutting against equally large areas of granite, which granite, as I showed in a paper read at the British Association Meeting at Exeter,[1] occasionally passes quite gradually and imperceptibly into gneiss. The latter rock is, however, not seen at this particular spot. In the immediate neighbourhood of Coadry the junction between the mica-schist group and the granitic mass is well seen and easily followed. It is shown tolerably correctly in the "Carte Géologique du Finistère."

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[1] Notes on some Granites in Western Brittany.

At and near this junction the rock is true mica-schist, of a dark greenish-grey colour, with spangles of mica of large size. In these beds none but a few very small specimens of Staurolite were met with, but these were all beautifully perfect, double, and crossed at right-angles. A little further from the junction the crystals (still perfect and crossed at right-angles) are to be found in great abundance and of large size, some as much as 2 in. × 2 in., studding the rock (which is here less micaceous and more quartzose) by hundreds. A stream cuts through this portion of the series, and its bed is naturally full of those large twin crystals, which are very easily detached from their parent rock, and it is evidently here that the "Pierres de croix" are found. The band in which these fine specimens abound is about thirty or forty yards in breadth, and near its inner margin (that furthest from the granite) there is a large proportion of crystals, crossed in the manner of a St. Andrew's cross. Beyond this band, in a very similar rock, but of a rather lighter colour and more friable, the number of crystals of the latter kind is much smaller, and with few exceptions the majority of the others, although crossed at right-angles, are formed of unequal prisms, one of them being in length smaller than the width of the other. This is also the case with the diagonally-crossed crystals, though more rarely. This last band of rock is about twice the breadth of the preceding one, and is succeeded by a large area of less micaceous clayey schists of a light yellow colour, sometimes hard enough to be used for building purposes, sometimes crumbling like earth in the hand. As we enter this region, the double crystals become rarer and rarer, and soon die out altogether, giving place to single prisms of all sizes, some reaching a length of from three to four inches. These single crystals are much softer than the double ones, and, when found in the more earthy parts of the schists, seem to form the nuclei of clayey concretions, distinguishable chiefly by their colour, which is of a darker tint than the rest of the rock. I was not able to ascertain where this "single crystal" zone ends, either in the Coadry district or at Lhominé, but about a mile from the junction with the granite no traces of Staurolite ever repaid my search, although, in several instances, brownish clayey nodular-looking patches were seen very similar to those just mentioned.[1]

Without attaching any undue importance to the facts I have just described, the connexion between them and those brought forward by Fuchs appears to be sufficiently obvious. The gradual indications of metamorphism which he observed in the Pyrenees to be accompanied by the formation of Andalusite and Chiastolite, are apparently repeated to some extent in Brittany, with the substitution of a mineral nearly allied to the two last-named ones in chemical composition, and with the addition of the physical details furnished by the peculiar changes in its mode of crystallization exhibited by Staurolite. Whether we have in either case the means of measuring, even to a certain extent, the amount of alteration undergone by the parent rock, it would be rash to say; but the facts given are suggestive, and seem to tend that way.

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[1] All the specimens are when found *in situ* of a light rusty-brown colour, the black colour of those bought at fairs being due to polishing with oil.

I may, before leaving the subject, remind readers of the GEOLOGICAL MAGAZINE, that Staurolite has never been found out of strongly metamorphic rocks, nor has it ever, I believe, been found, as Andalusite has been said to be, in granite. I give below two analyses of Staurolite from Brittany, by Jacobson, which I have borrowed from those given in Phillips's Mineralogy (1852 edition, p. 283).[1]

ANALYSES.

	a.	*b.*
Silica	39·19	40·35
Alumina	44·87	44·22
Red oxide of iron...	15·09	15·77
Ox. mangan....	0·17	0·10
Magnesia	0·32	—

V.—ON SOME SUPPOSED FOSSIL REMAINS OF *ARACHNIDA* (?) AND *MYRIOPODA* FROM THE ENGLISH COAL-MEASURES.

By HENRY WOODWARD, F.G.S., F.Z.S.,
Of the British Museum.

IN the fourth part of my Monograph on the MEROSTOMATA, published in last year's volume of the Palæontographical Society's annual issue,[2] I drew attention to two very singular fossil remains which had been somewhat doubtfully referred by Mr. J. W. Salter to the genus *Eurypterus*. A portion, at least, of the remains referred by him to *Eurypterus ? mammatus* are really plant-remains (as shown by Mr. Carruthers, op. cit., p. 168), whilst the remainder must, for the present, be classed with M. Jordan's *Arthropleura armata*, from the Coal-measures of Saarbruck, Rhenish Prussia, a very anomalous Crustacean (if it be a Crustacean at all, which I greatly doubt), but which is certainly not a *Eurypterus*.

With reference to *Eurypterus ferox*, I think (upon comparison) it may with propriety be referred to the MYRIOPODA under Messrs. Meek and Worthen's genus *Euphoberia*.

Species 1.—"*Eurypterus ? mammatus*," Salter; H. Woodward, Pal. Soc. Mon. 1872, part iv., p. 163, pl. xxiv., figs. 2–6.

Eurypterus (*Arthropleura ?*) *mammatus*, Salter, 1863. Quart. Journ. Geol. Soc., vol. xix., p. 84, figs. 1–7.

This species was determined by Mr. J. W. Salter in 1863, from fragments referred by him "to the head (see Woodcut, Figs. 1, 2, and 3), to the lateral portions of the body-segments, and parts nearer to the tail (Woodcut, Figs, 4, 5, 6, and 7); but of the central surface of the carapace, of the eyes, or of the appendages, nothing is known."

The first fragment was discovered by Mr. Gibbs, the intelligent collector of the Geological Survey, in splitting up the shales at the mine-top, Pendleton Colliery, Manchester. Other specimens were afterwards obtained by Messrs. Gibbs and Rhind, who ascertained the exact bed from which these remains were derived, and which proved to be the "Ferny Metal," under the "Big Coal" or "Ram's Mine."

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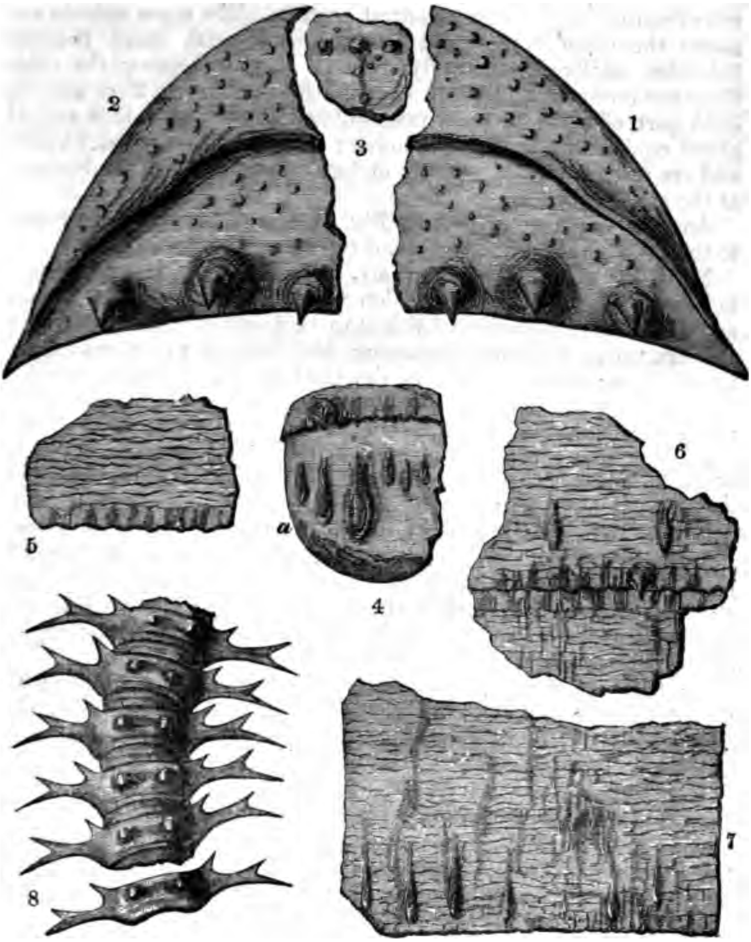
[1] The locality "Quimper" given for Staurolite in this work is undoubtedly *erroneous.*

[2] p. 163.



Figs. 1-7.—*Eurypterus* (*Arthropleura ?*) *mammatus*, Salter.
Fig. 8.—*Arthropleura* (*Euphoberia ?*) *ferox*, Salter.
(From the Quart. Journ. Geol. Soc., 1863, vol. xix., p. 84.)

The plants occurring in this bed, noticed by Mr. Salter, are:—*Lepidodendron obovatum*, Sternb.; *L. Sternbergii*, Brong.; *L. elegans*, Brong.; *Neuropteris Loshii*, Lindl.; *N. heterophylla*, Sternb.; *N. gigantea*, Sternb.; *Cyclopteris flabellata*, Brong.; *Sphenopteris obtusiloba*, Brong.; *Sp. latifolia*, Brong., and some others.

The bed lies rather high in the "middle Coal series."

The specimens figured in the accompanying Woodcut, Figs. 1 and 2, are considered by Mr. Salter to be the lateral portions of the head-shield, which he thinks must have been at least 8 or 9 inches across. It shows a strongly arched border running out into a short acuminate broad spine, into which a strongly curved sharpish ridge runs from about the upper central portion. The space outside and above the ridge is flat, and is ornamented with small rounded tubercles scattered irregularly over its surface; below the ridge there are fewer tubercles, but near the hinder border there are two (and part of a third) large mammillated tubercular spines ranged about equidistant from one another; they are directed backwards, and are fully a third of an inch in length, and as much in diameter at the swollen base.

Another fragment (Woodcut, Fig. 3), also referred by Mr. Salter to the head, shows large and small tubercles upon its surface.

Mr. Salter speaks of "at least six, and probably more, of the large mammillated tubercular spines along the hinder border" (of Figs. 1 and 2). The explanation of this is to be found by referring to the accompanying woodcut illustrating Mr. Salter's paper, which by the kindness of the Council of the Geological Society we are able to reproduce here (see Quart. Journ. Geol. Soc., vol. xix., p. 85) when it will be seen that this specimen (Fig. 2) has been drawn *twice over* (once reversed, and once in its natural position), so as to give the effect of a crescent-shaped shield. But only the piece represented as Fig. 2[1] exists, and after careful comparison I am quite unable to refer it to the head-shield of any known Crustacean.

Referring to the above woodcut, Mr. Salter observes, "Although I have supposed Figs. 1 and 2 to belong to the head, I have really little else to recommend this view than the great comparative size and breadth, and the general form, which is like that of the hinder angles of the head of the Scotch *Eurypterus*."[2]

Mr. Salter then proceeds to contrast his *Eurypterus mammatus* with the *Arthropleura armata* of Jordan, a species founded upon the fragments of a large Crustacean (?) from the Coal-measures of Saarbruck, Rhenish Prussia.

If the subjoined woodcut (Fig. 9, B) of *Arthropleura armata* be compared with Woodcut Fig. 1, a somewhat similar piece (marked *p*), having a corresponding raised border and similar arrangement of tubercles, will be seen, suggesting that this pointed portion (Fig. 1) may more likely be the pleuron of a trilobed segment. This interpretation, although rejected by Mr. Salter, seems to me, on many accounts, more probable than the alternative one which he has adopted, namely, that of supposing it to be the posterior angle of the head-shield of *Eurypterus*, with which indeed it seems exceedingly difficult, if not impossible, to associate it.

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[1] It is quite apparent, however, from Mr. Salter's description, that he was under the impression that *two* specimens existed *in reality* as well as in his figure. I have therefore specially noticed this, lest hereafter it should be supposed that one of these curious fragments had really been lost.

[2] If by the Scotch *Eurypterus* Mr. Salter refers to *E. Scouleri*, a comparison between the fragment of *E. mammatus* and the entire head of *E. Scouleri* will satisfy any palæontologist that such a hinder angle could not possibly be fitted to the carapace of the latter; the *curvature* and ornamentation being both incongruous. No other form with which we are acquainted could have required so large an epimeral piece save the great Devonian *Stylonurus Scoticus*.

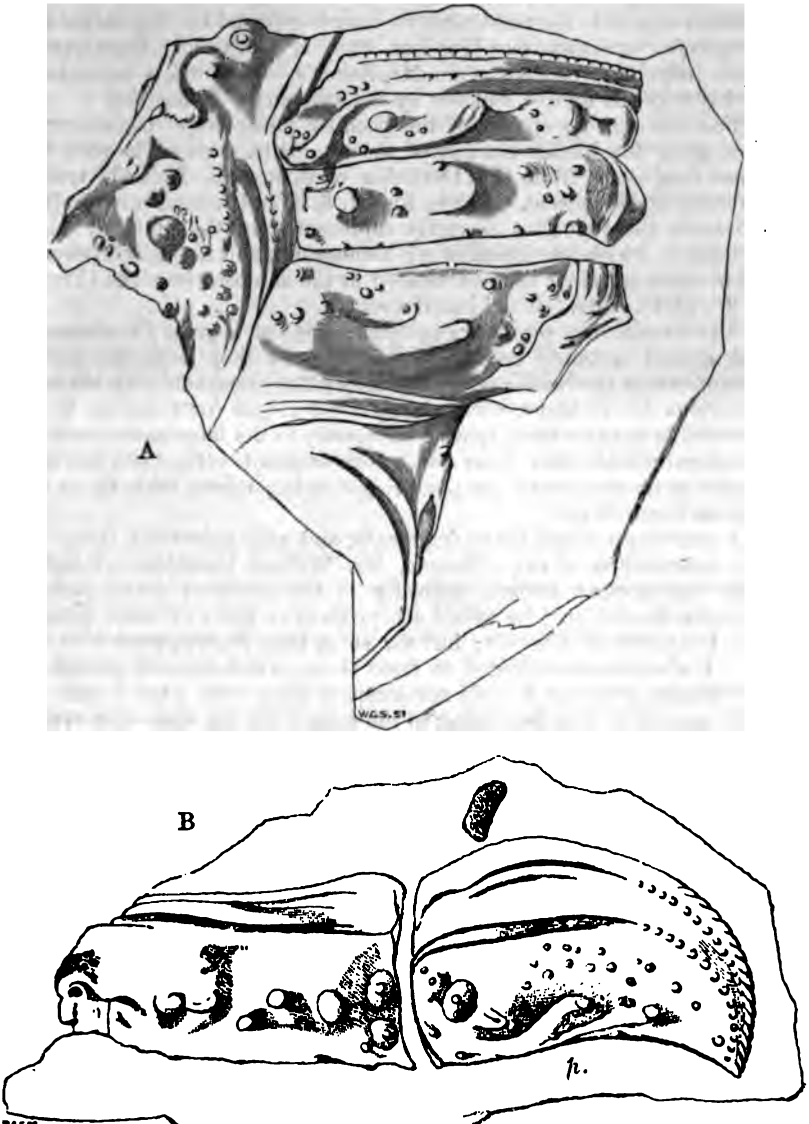

Fig. 9, A and B.—*Arthropleura armata*, Jordan. Coal-measures, Saarbruck, Rhenish Prussia. *Copied from* Palæontographica, 1856, band iv., taf. 2, figs. 4 and 5.

Assuming it to be, like Jordan's *Arthropleura armata*, part of the body-segment of some large palæozoic Crustacean (such as *Stylonurus Scoticus*,[1] or that singular form named by me *Præarcturus gigas*, from the Old Red Sandstone of Herefordshire),[2] it seems almost certain that this fragment has no affinity whatever with *Eurypterus*.

With regard to the remaining fragments referred by Mr. Salter to *Eurypterus mammatus* (see Woodcut, Figs. 4, 5, 6, and 7), I am in no little difficulty; for here again Mr. Salter's description is borne out by his woodcut figures, but not by the specimens themselves.

For instance, he speaks of the peculiar "tear-drop" ornamentation along the hinder margin of the segments, such as is seen in some fragments from the Devonian of Kiltorcan, Ireland, truly referred to *Eurypterus*. But in Figs 4, 5, 6, and 7, these are really *cracks* in the tissue, as correctly represented in the plate by Mr. Griesbach, which accompanies my Monograph, and not raised tubercular ornamentations thereon, as seen in the annexed woodcut (Figs. 4, 6, and 7). Mr. Salter himself says:

"The remaining pieces are evidently parts of a great Crustacean, and almost certainly belong to this one, for they have the same ornaments on the hinder edge; but they differ remarkably by having a curious set of short, wavy, interrupted ridges (or furrows, it is impossible to say which) lying transversely to the length, and which are equally distributed over the whole segment. They are not all of the same size, small rounded ridges being mixed with those of a more linear shape."

I carefully studied these fragments, and also submitted them to the examination of my colleague, Mr. William Carruthers, F.R.S., who has devoted himself specially to the study of fossil plant-remains, hoping that he would accept them as parts of some plant, like *Calamites* or *Knorria;* but for some time he was unable to do so. I was therefore obliged to treat them as animal, and probably Crustacean, although I could not compare them (like Figs. 2 and 3) with any other form belonging to the order; for the scale-like ornamentation so characteristic of *Pterygotus* and *Eurypterus* is altogether wanting, nor could I detect any evidence of spines such as are preserved on Fig. 2.

Fortunately at this juncture a portion of an undoubted plant-stem from the Ironstone of the English Coal-measures, which Mr. Carruthers had laid aside for examination, turned up, and furnishes evidence of markings *identical* with those exhibited on Figs. 4, 5, 6, and 7, so that there is no longer any reason to doubt their vegetable origin. Mr. Carruthers has very kindly drawn up an account of these remains, which accompanies my Monograph, so that they may now be considered as disposed of in a satisfactory manner.[3]

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[1] See Pal. Soc. Mon. Merostomata, part iv., and pl. xxii. and xxiii.

[2] Trans. Woolhope Naturalists' Field Club, 1870, p. 266. 'Fossil Sketches,' No. 9, figs. 1 and 2, and No. 10.

[3] This account, together with some further observations, which Mr. Carruthers has kindly promised to furnish, will appear in the April Number of the GEOLOGICAL MAGAZINE.—EDIT. GEOL. MAG.

The remaining specimens (Woodcut Figs. 2 and 3) have been retained to represent Salter's species, which is referred provisionally to M. Jordan's genus as *Arthropleura mammata*, Salter, sp., about the affinities of which we cannot, however, at present speculate with much certainty, although there are grounds for believing that *Arthropleura* may eventually prove to be a part of a giant Arachnide!

In the mean time it is interesting to record the discovery, by W. G. M'Murtrie, Esq., of Camerton, of three tuberculated epimeral pieces, so exactly resembling that marked *p* in the accompanying woodcut, Fig. 9 B, that except for the variation in the wart-like tubercles, two of them might at once be mistaken for M. Jordan's type. There is the same deep groove in each, the same falcate border, the same admixture of large and small tubercles, upon the surface of each, occupying relatively the same positions.

The third specimen is more waved along its anterior curved border, and the hinder border is straighter than in Jordan's figure. They were obtained by Mr. M'Murtrie from the roof-shale of "Top-Little-Vein," Camerton Collieries, and, like the Manchester specimens, are from Plant-shale, and are associated with remains of *Neuropteris*, *Pecopteris*, etc. Now that its occurrence has been noted from two English localities, wide apart, we may hope for further specimens to turn up, throwing more light on this curious Carboniferous Arthropod.

Species 2.—"*Eurypterus*? (*Euphoberia*) *ferox*, Salter; H. Woodward, Pal. Soc. Mon., 1872, part iv. p. 171.

Eurypterus? (*Arthropleura*) *ferox*, Salter, 1863. Quart. Journ. Geol. Soc., vol. xix., p. 86, woodcut fig. 8.

INSECTA, Caterpillar? J. O. Westwood, in Brodie's Fossil Insects in the Secondary Rocks of England, 1845, p. xvii., p. 115, pl. i., fig. 11.

Accompanying Mr. Salter's description of *Eurypterus* (*Arthropleura?*) *mammatus*[1] is a notice of another form named by him *Eurypterus* (*Arthropleura*) *ferox*. The specimen described forms Fig. 8 of the woodcut reproduced on p. 105 from Mr. Salter's paper, and was obtained by Mr. Charles Ketley (of Smethwick) from the Clay Ironstone nodules in the shale over the "thick coal" of the Coal-measures, Tipton, Staffordshire, associated with abundance of fossil plants.

Mr. Salter observes, "At first sight it would strike an entomologist as a fossil Caterpillar of the genus *Saturnia*, so strong is its resemblance in size, form, and ornament to the larvæ of that group. Unlike most Crustaceans from the old rocks, it is extravagantly ornamented with long forked spines." Such spines are found on the carapace of *Lithodes*, and also on the segments of the abdomen of the "Murray River Cray-fish," *Potamobius astacus*.

Mr. Salter considers von Meyer's *Arthropleura armata* (already referred to) to belong to *Eurypterus* (see Woodcut, Figs. 1–7), and thinks it possible to assign both his *E. mammatus* and *E. ferox* to the same group.

In a "History of Fossil Insects of the Secondary Rocks of England," by the Rev. P. B. Brodie, M.A., F.G.S., 8vo. published in 1845, some specimens are figured from the collection of the Rev. F. W. Hope,[1] now preserved in the Oxford Museum.

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[1] Quart. Journ. Geol. Soc., vol. xix. p. 86, and woodcut fig. 8, p. 84. Reproduced in this *Article at p. 105.*

Among others is a specimen "from Coalbrook Dale, which has very much the appearance of some large Caterpillar, furnished with rows of tubercles, to which setæ or bristles were attached, as in the case of the caterpillar of our common English Emperor Moth (*Saturnia Pavonia minor*): unfortunately the specimen is imperfect at each end, and therefore it is impossible to judge of the appendages of the head or tail. It will be seen that there appear to be distensions of the membrane connecting several of the segments of the body together, as between the first and second, second and third, fourth and fifth (on the right hand side), and seventh and eighth (see the accompanying Woodcut, Fig. 10). Now this could not, I think, occur to so visible an extent in a Lepidopterous larva, because it seems to intimate that the broader parts of the body (or the true segments) are of a firmer texture than the connecting distendable membrane. The lateral series of long, slender and *evidently articulated* appendages seem also to throw a doubt on the Insect being a Lepidopterous larva. These appendages have some remote analogy to those of a portion of the segments of *Squilla*, but this is only in appearance, and not a real relationship. The dark line which runs down the back seems quite analogous to the great dorsal vessel or heart of the Caterpillars." (Introductory Observations by J. O. Westwood, M.A., F.L.S., in Brodie's "Fossil Insects," p. 18.)

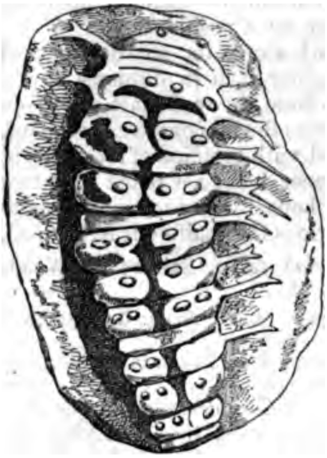

FIG. 10.—*Arthropleura ferox*, Salter. Specimen figured by the Rev. P. B. Brodie, preserved in the Hope Collection, Oxford, from the Coal-measures, Coalbrookdale. [Copied from plate i. fig. 11, of Brodie's 'Fossil Insects.']

Among the numerous interesting remains of Arthropoda from the Coal-measures of Illinois, figured and described by Messrs. F. B. Meek and A. H. Worthen, in the "Palæontology of Illinois," published in vol. iii. of the publications of the Geological Survey of Illinois (1868), is a specimen which there can be little doubt is identical with that figured and described by Mr. Salter as *Eurypterus ferox*, and by Mr. Westwood as the "larva of some unknown insect." (See the accompanying Woodcut, Fig. 11.)

Messrs. Meek and Worthen provisionally refer their specimen to the Myriopoda and to their genus *Euphoberia*, under the name of *Euphoberia? major*, M. and W.

A smaller species of *Euphoberia*, also armed with forked spines;

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[1] The Founder of the Hope Professorship of Zoology in the University of Oxford, *so ably filled by Prof. J. O.* Westwood, M.A., F.L.S., the eminent Entomologist and *Carcinologist.*

named *E. armigera* was found in the Coal-measures of Grundy County, Illinois, and is described in the same work by Messrs. Meek and Worthen. A specimen equalling in size their *E. armigera* was figured and described by the writer in the GEOLOGICAL MAGAZINE, 1871, Vol. VIII. Pl. III. Fig. 6, p. 97, from the Coal-measures near Glasgow, under the name of *E. Brownii.*

Messrs. Meek and Worthen write as follows respecting their specimen of *Euphoberia? major* (see Woodcut, Fig. 11):

"We unfortunately yet know it only from fragments, one of the best of which is represented by the annexed cut. If as long in proportion as the other species, it probably attained a length of twelve to fifteen inches, and must have presented a formidable appearance. The node-like prominences marked (*n*) in the figure are evidently the bases of spines that have been broken away. One of these, however, is seen lying in the matrix at the point marked (*s*). Another specimen shows a direct view of the dorsal side compressed flat. In this traces of two rows of these node-like prominences are seen along the middle, while a row of spines can be seen projecting out into the matrix on each side. This latter specimen so nearly resembles a fossil figured by Mr. Salter, in the Quarterly Journal of the Geological Society of London, vol. xix. p. 84, fig. 8, from the Staffordshire Coal-measures, under the name of *Eurypterus* (*Arthropleura*) *ferox,* that we can scarcely entertain a doubt that they are congeneric. Indeed, if it were not for the fact that the species *ferox* has its spines provided with three instead of two prongs, we would even suspect that our specimens might possibly belong to the same species.

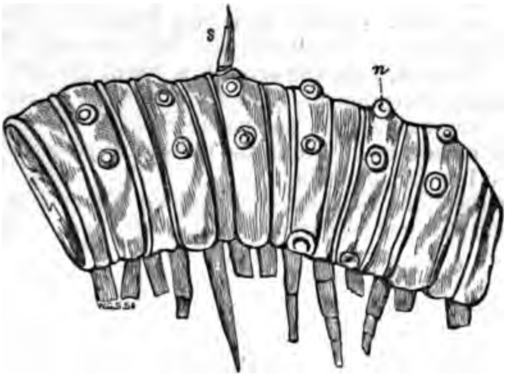

FIG. 11.—*Euphoberia? major,* from the Coal-measures, Grundy Co., Illinois, U.S.A. [See Messrs. Meek and Worthen's 'Palæontology of Illinois,' 1868, vol. iii. p. 558. One dorsal spine (*s*) still remains *in situ;* the nodes (*n*) are evidently the bases of spines. Several pairs of the legs are seen below.]

"Mr. Salter thought his specimen probably a part of the central lobe of a trilobate *Eurypterus* or some allied genus, an opinion he would not have entertained for a moment, provided we are right in our suggestion respecting its relations to our fossil, if he had seen a specimen showing a *side-view* of even a few of the segments with their legs attached. At any rate our fossil is certainly distinct from the genus *Arthropleura* of Jordan and von Meyer, which is almost beyond doubt a Crustacean."[1]

After carefully examining the English *E. ferox* of Mr. Salter, and comparing it with Messrs. Meek and Worthen's figure and description, I am disposed fully to agree with the latter writers, and to refer it to the Myriopoda and to their genus *Euphoberia*, feeling certain that it has no relation whatever with *Eurypterus*.

The reasons why *E. ferox* should no longer be retained with the *Eurypteridæ* may briefly be stated: 1. We know of no undoubted *Eurypterus* with body-segments ornamented with spines or tubercles like those of *E. ferox*. 2. The segments, when seen in series, are never (in *Eurypterus*) of a uniform size, but invariably diminish, as regards their breadth, from the seventh segment towards the telson. With the single exception of *Eurypterus Scouleri* (a most aberrant form of the *Eurypteridæ*), all the members have the segments but very slightly arched, and (save in the three most posterior segments) always much broader than long.

We may therefore consider Mr. Salter's *Eurypterus? ferox* as excluded from the genus *Eurypterus*, and also from Jordan's genus *Arthropleura*, and may refer it with considerable confidence to Messrs. Meek and Worthen's Myriopodous genus *Euphoberia*.

Formation.—Coal-measures; Clay-ironstone. *Localities.*—Coalbrookdale, Shropshire; Tipton, Staffordshire. *Foreign Localities.*—Coal-measures, Grundy County, Illinois, U.S. America.[2]

VI.—NOTE ON A CARBONIFEROUS SPECIES OF *ORTONIA*.

By JOHN YOUNG.

THE new species of Fossil Tubicolar Annelides, from the Lower Silurian strata of America, figured and described by Prof. H. A. Nicholson in the October and February Numbers of the GEOLOGICAL MAGAZINE, has tended to throw light upon a closely allied form found in the Carboniferous Limestone strata of the West of Scotland. This species, as far as I am aware, has not hitherto been figured or described.

Several years ago, when I discovered this form, I was struck by its general resemblance to a small *Tentaculites;* but as my specimens—which are well preserved—showed that they had been attached to other organisms, chiefly to spines of *Productæ*, I saw that it could not be in any way related to the free unattached forms referred to that genus. I therefore retained it amongst the *Serpulæ*. I am now, however, satisfied that, if not identical, it at least is very closely related, to Prof. Nicholson's genus *Ortonia*, and especially to his *O. minor*, described and figured in the February Number of the GEOLOGICAL MAGAZINE. I am the more inclined to this opinion, as I see that Prof. Nicholson does not now make the cellular structure, which is observed in *O. conica*, a point of generic distinction,—that structure being wanting in both *O. minor* and the Carboniferous form.

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[1] Op. cit. p. 558.

[2] The author desires to record his thanks to the Council of the Palæontographical Society for granting him permission to use the woodcuts which illustrate this paper; which is, to a large extent, reprinted from his Memoir on the Merostomata in the 1872 volume of that Society's publications.

This species, for which I would propose the name *Ortonia carbonaria*, may be briefly described as follows.—Tube circular, conical, calcareous in structure, solitary; generally found attached by their whole length to the spines of *Productæ*, straight, or slightly curved, or flexuous. Ornamented with sharp annulations or transverse ridges, the interspaces being rather wider than the ridges. Marked longitudinally with microscopic striæ. Length $\frac{1}{8}$ to $\frac{1}{4}$ inch; diameter of tube at mouth $\frac{1}{80}$ to $\frac{1}{30}$ inch; 35 annulations in $\frac{1}{4}$ inch.

This species I have found to be somewhat rare when searching our Limestone shales for Foraminifera and Entomostraca. It occurs in both the Lower and Upper Limestone series at several localities near Glasgow; but I have found it most numerous in the Lower Limestone shales at Brockley, near Lesmahagow. The great majority of the specimens are, or show that they have been, attached to the slender spines of *Productæ*, sometimes two or more being found upon a fragment of the same spine, but more often occurring singly.

The enlarged figure of *Ortonia minor*, Pl. IV., Fig. 2*a*, fairly represents the external form of the Carboniferous species, as seen in many of the specimens, and might serve for an illustration, if we excepted the more minute markings which distinguish it from the Silurian form.

VII.—NOTES AND QUERIES ON THE CLASSIFICATION AND NOMENCLATURE OF THE ENGLISH STRATA.

(Communicated by W. S. M.)

Abbreviations.—A. *a.*—Recognized as a separate formation with definite limits, by
b.—In the year
c.—Where published
d.—Under the name
e.—Origin of name
B.—Changes on previous grouping or name
C.—Subsequent changes

CHALK. A. (*a*) William Smith. (*b*) 1799. (*c*) In his first table. (*d*) Chalk. (*e*) Adopted general name.
B. None.
C. In 1816 he divided it into Upper and Lower.

Con. and Phil. in 1822 divided into "with flints," "with few flints," "without flints," and recognized the underlying "Grey Chalk," which they state might more properly be designated "Chalk Marle." The term Chloritic Marl (a division underlying the Chalk Marl) originated in

UPPER GREENSAND. A. (*a*) Fitton. (*b*) 1824. (*c*) An. Phil., vol. viii. p. 365. (*d*) Firestone. (*e*) Adopted the local Isle of Wight name. [Query—Only I. of W.?]

B. From the time of Smith's maps[1] of England, and of Webster's letters to Englefield (1816), the deposits between the Portland beds and the Chalk were regarded as naturally divided thus:—1. Greensand; 2. An argillaceous deposit (Tetsworth Clay of Greenough); 3. Ironsand.

Conybeare and Phillips (1822) followed this division, giving No. 2 the name "Weald Clay" which had been suggested by P. J. Martin.

In mapping they grouped the "Chalk Marle" with the Greensand. Their small map, based on a reduction of the Greenough map, published three years earlier, shows that while in some districts advance had been made in recognizing the distinctiveness of formations which Smith had confounded together, yet that in other districts they still mistook Lower Greensand for Hastings sand, Galt for Weald Clay, and even Kimmeridge Clay for Weald Clay. The first who pointed out the existence of Upper Greensand, Galt, and Lower Greensand, as apart and quite distinct from Weald Clay and Hastings-sand, was Fitton, in a paper in the An. Phil., 1824, vol. viii., "On the Beds between Chalk and Purbeck." [Sedgwick had, in 1822, in the An. Phil., pointed out that in the Cambridge district the Greensand above the tenacious Blue Clay which rests on the "Ironsand" is not the same as the beds so named elsewhere, *i.e.* the (Lower) Greensand.] He shows this to be so in the I. of W. and S. E. of England, and gives evidence in favour of the Galt, his "Marl of Folkestone" and "Clay of Undercliff" being identical with the Galt of Cambridge, and adds that the greater part of England has not been examined with sufficient care to admit of correlation.

C. Fitton's position for his Firestone has remained unaltered, but the name was changed to Upper Greensand. [I cannot be sure who made the change in the first place. Firestone was inapplicable in a large portion of England, and the change was but a restoration of Smith's name (which Sedgwick insisted on in 1826, An. Phil. p. 343). Query—When was "Upper" added?]

HUNSTANTON RED LIMESTONE. A. (*a*) Seeley. (*b*) 1861. (*c*) An. Mag. Nat. Hist. Ap., 1861. (*d*) Hunstanton Red Limestone. (*e*) Hunstanton being the typical locality.

B. Sedgwick, in the An. Phil., 1822, hinted that it was distinct from Chalk. Wiltshire, in 1859, Proc. Geol. Assoc., suggested, amongst other hypotheses, that it was a formation intermediate between the Chalk and Lower Greensand.

C. Clearly separated from Red Chalk in 1864. (Quart. Journ. Geol. Soc., November, 1864.)

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[1] I have used the word in the plural with an intention. Many modifications were made in the mapping during the period of the issue of the different copies. They were not called separate editions, but containing such differences they can hardly be spoken of as the *same* map.—W. S. M.

LT.[1] A. (*a*) Fitton. (*b*) 1824. (*c*) An. Phil., vol. viii. p. 365. (*d*) Clay of the Undercliff or Gault. (*e*) Galt is said to be a local name. [Query—In what county or counties is it used and in what sense? See Fitton, Geol. Journ., 2 ser. vol. iv. p. 306, 1836.]

B. See *suprà*. C. None.

NOTICES OF MEMOIRS.

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—On a New Sub-class of Fossil Birds (*Odontornithes*). By Prof. O. C. Marsh, Yale College, Ct., U.S.A.

HE remarkable extinct birds with biconcave vertebræ (*Ichthyornidæ*), recently described by the writer from the upper Cretaceous le of Kansas,[2] prove on further investigation to possess some litional characters, which separate them still more widely from all own recent and fossil forms. The type species of this group, *thyornis dispar*, Marsh, had well developed *teeth in both jaws.* ese teeth were quite numerous, and implanted in distinct sockets. ey were small, compressed and pointed, and all of those preserved similar. Those in the lower jaws number about twenty in each ius, and are all more or less inclined backward. The series ends over the entire upper margin of the dentary bone, the front th being very near the extremity. The maxillary teeth appear to e been equally numerous, and essentially the same as those in the ndible.

he skull was of moderate size, and the eyes were placed well ward. The lower jaws are long and slender, and the rami were closely united at the symphysis. They are abruptly truncated behind the articulation for the quadrate. This extremity, and ecially its articulation, is very similar to that in some recent atic birds. The jaws were apparently not encased in a horny ath.

he scapular arch, and the bones of the wings and legs, all conform ely to the true ornithic type. The sternum has a prominent l, and elongated grooves for the expanded coracoids. The wings e large in proportion to the legs, and the humerus had an nded radial crest. The metacarpals are united, as in ordinary ls. The bones of the posterior extremities resemble those in mming birds. The vertebræ were all biconcave, the concavities ach end of the centra being distinct, and nearly alike. Whether tail was elongated cannot at present be determined, but the last ebræ of the sacrum was unusually large.

he bird was fully adult, and about as large as a pigeon. With exception of the skull, the bones do not appear to have been umatic, although most of them are hollow. The species was ivorous, and probably aquatic.

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[1] This is sometimes spelt Golt (as by Rev. J. Mitchell in his Table of Sequence,) and Gault. I believe Galt to be correct.

[2] illiman's Journ., vol. iv. p. 344, Oct. 1872, and vol. v. p. 74, Jan., 1873.

When the remains of this species were first described, the portions of lower jaws found with them were regarded by the writer as reptilian;[1] the possibility of their forming part of the same skeleton, although considered at the time, was not deemed sufficiently strong to be placed on record. On subsequently removing the surrounding shale, the skull and additional portions of both jaws were brought to light, so that there cannot now be a reasonable doubt that all are parts of the same bird. The possession of teeth and biconcave vertebræ, although the rest of the skeleton is entirely avian in type, obviously implies that these remains cannot be placed in the present group of birds, and hence a new sub-class, *Odontornithes*, is proposed for them. The order may be called *Ichthyornithes*.

The species lately described by the writer as *Ichthyornis celer* also had biconcave vertebræ, and probably teeth. It proves to be generically distinct from the type species of this group, and hence may be named *Apatornis celer*, Marsh. It was about the same size as *Ichthyornis dispar*, but of more slender proportions. The geological horizon of both species was essentially the same. The only remains of them at present known are in the museum of Yale College.

The fortunate discovery of these interesting fossils is an important gain to palæontology, and does much to break down the old distinctions between Birds and Reptiles, which the Archæopteryx has so materially diminished. It is quite probable that that bird, likewise, had teeth and biconcave vertebræ, with its free metacarpals and elongated tail. (Appendix to *Silliman's American Journ.*, Feb., 1873, p. 161.)

II.—Vazeeri Rupi, the Silver Country of the Vazeers in Kulu; its Beauties, Antiquities, and Silver-mines: including a Trip over the Himalayah Range and Glaciers. By J. Calvert, F.G.S., Mem. Inst. C.E. With numerous Illustrations. 8vo. (London and New York, 1873.)

KULU is the mountainous region drained by the headwaters of the River Beas, and of the Malauna, Parbutti, Harla, and Sainj, its tributaries. These rise partly in the high range (21,772 feet) bounding Spiti on the west, and partly in the Deobita (20,417 feet) and Rohtang (15,506 feet) range. Near to and parallel with the northern and steepest side of the latter runs the Chandra River, receiving the waste of the Shigri, Perad, Sack, and Hamta Glaciers. A portion of Kulu, crossed nearly at its centre by Lat. 32° N. and Long. 77° 30′ E., is "the Silver Country of the Vazeers," with an area of 677 square miles and a population of about 8000. The mines were closed, built up, and planted over some years ago, on the invasion of the Sikhs; and the wealth of silver, copper, and antimony appears to have been nearly forgotten, until the energy of recent speculation once more opened up the mineral riches of this district.

The great Kulu (or Kooloo) valley, noted for its beautiful scenery, about 115 miles north of Simla, is traversed by many, who pass over the Himalayahs on business, or for adventure and sport; and for geologists at home it is pleasant to accompany an intelligent traveller, page by page, who knows not only how to gossip, but how to point out the physical geography, the structure, and mineral characteristics of his route through this interesting region of North India. With a clear map and numerous good illustrations of scenery and of buildings (both old and new), and of the handsome European-like Kulu people, Mr. Calvert materially aids the reader to follow his track by river-side and mountain-pass, through the picturesque villages, and among the mines, and frequent exposures of unworked lodes in this "Silver Country of the Vazeers."—T. R. J.

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[1] Silliman's Journ., vol. iv., p. 406, Nov. 1872.

III.—TRANSACTIONS OF THE NEWBURY DISTRICT FIELD-CLUB, ESTABLISHED 1870. 8vo. (Newbury, 1871.)

DESIGNED to promote the knowledge of the Natural History and Antiquities of the neighbourhood, this Society has already applied itself with industry and acumen to the cultivation of the rich fields of natural science around Newbury, in both Berks and Hants. The current evidences of its activity, since 1870, have been the well-arranged excursions to points of interest, and the social discussion of new and old facts, and of matured and nascent opinions. The more lasting and tangible results are visible in the handsome and well-printed volume before us, with its woodcuts, lithographs, and photographic illustrations. For Geologists it offers papers on the Geology of the Kennet Valley, of North Hampshire, and of the Kingsclere Valley; and on the nature and origin of the well-known Sarsen stones. The Botanist, Ornithologist, and Entomologist have excellent matter given them. The Antiquarian and the Scholar are also largely supplied with facts and thoughts relating to the history of this richly-storied region.—T. R. J.

IV.—NINTH ANNUAL REPORT OF THE BELFAST NATURALISTS' FIELD-CLUB, 1871-72. 8vo. 65 pages. (Belfast, 1872. Printed for the Members only.)

BESIDES cursory notices of points of geological interest near Belfast, at Woodburn Glen, and elsewhere, and in South Donegal, visited by the Club in Summer excursions, this Report contains a paper by Mr. W. Gray, on the very slight probability of coal being found in the neighbourhood of Belfast; and a paper by Mr. Joseph Wright, on the geology of Cultra in County Down, in which he shows that some of the so-called Permian beds there are really of Carboniferous age.

The Naturalists and Antiquaries are evidently active at Belfast, for this Report contains many interesting and thoughtful notices of the botany, zoology, and antiquities of the vicinity.—T. R. J.

V.—CEPHALOPODA OF THE CRETACEOUS FORMATION OF BOHEMIA. By Dr. ANTON FRITSCH. (Cephalopoden der böhmischen Kreide-Formation, etc.) 4to. Prague, 1872.

THIS elegant and well-printed Monograph has been brought out under the auspices of the Geological Survey of Bohemia. Dr.

Urb. Schlönbach, who worked with Dr. A. Fritsch in field and cabinet, from 1867 to 1870, on the subject-matters of this Monograph, unfortunately died before its completion.

Bibliography, characterization and comparison of species, their local occurrence and distribution, are carefully treated of; and sixteen plates of full, clear, and artistic lithographs of thirty-nine out of fifty-five species described, of which seventeen are new, complete this welcome addition to Cretaceous Palæography. The genera affording the Bohemian species are *Glyphiteuthis, Belemnites, Nautilus, Rhyncholithus, Ammonites, Scaphites, Hamites, Helicoceras, Baculites,* and *Aptychus.* T. R. J.

VI.—Short Notices.

Fossil Myriopods, etc.—In the Proceedings of the Dresden "Isis" Society, 1872, p. 125, Prof. Dr. H. B. Geinitz describes some interesting fossils from Saxony. (1) A Calamite-like fossil from the very old (perhaps Cambrian) schists of Weesenstein (pl. 1, fig. 1); (2) *Lingula Rouaulti,* Salter, in quartzite from the Upper Lansitz (fig. 2); (3) a group of fossil Myriopods, with Wood (*Araucarites*), in a siliceous fragment from the Rothliegende, near Chemnitz (*Palæojulus dyadicus,* Geinitz, fig. 4-7). Can Fischer de Waldheim's "Spirolinites," in a piece of gravel flint, figured in his "Oryctologie de Moscou," pl. 12, fig. 4, be related to Prof. Geinitz's fossil, or to other *Julidæ*?

Cretaceous Polyzoa and Foraminifera.—In the 4th No. of Part I. of Geinitz's "Das Elbthalgebirge in Sachsen" (Rocks of the Elbe Valley in Saxony, 1872), pp. 97-134, Dr. A. E. Von Reuss describes numerous Bryozoa (*Polyzoa*) from the Lower Quader (Cretaceous), illustrated in ten beautiful lithographic quarto plates. from the Vienna State Printing-office; also at pp. 134-140, some of the Foraminifera from these beds, especially a fine Lituoline form (*Polyphragma cribrosum,* p. 139, pl. 33, fig. 8 *a-c*); and a remarkably large and interesting Foraminifer, which, long regarded as a Polyzoa, has passed under various names in books, as "Ceriopora," "Thalamopora," and "Monticulipora," but which Von Reuss now carefully works out (*Thalmopora cribrosa.* Goldf. sp., p. 137, pl. 33, figs. 11-15), and recognizes as the type of a new Foraminiferal family. Indeed this species is not only of interest as attaining a length of an inch and more, with proportionate thickness, but as exhibiting characters of alliance with so many other genera, as *Polytrema, Carpenteria,* and especially *Cymbelopora,* and through it with *Planorbulina* and other *Rotalinæ.* The author points out that *Thalamopora* is among the "perforate," what *Dactylopora* is among the "imperforate" Foraminifera.

Æpyornis.—In the Transactions of the Bologna Academy of [illegible]nces, 1872, series 3rd, vol. ii. (pp. 141-165, plates xix.-xxiv.). [illegible] J. J. Bianconi gives further information on the femur, tibia, and metatarsus of *Æpyornis*, corroborative of his views of *Æp. maximus* having been an immense vulturine bird—the "Roc" of Marco Polo.

H. B. GEINITZ ON THE CRETACEOUS INOCERAMI.—In working out the *Inocerami* for his work on the Geology of the Elbe Valley in Saxony, Prof. Geinitz has had to study these shells very closely. He reduces the species to eleven; and, commencing with *Inoceramus concentricus*, Sowerby, of the Gault (which points with others, he thinks, to a Liassic origin), he passes to *I. striatus*, Mantell, of the Cenomian stage (Lower Quader and Lower Pläner). This species gives off, as it were, in the same stage, *I. latus*, Mantell, which becomes in the next (Turonian or Middle Quader, Middle Pläner, and Pläner limestone) *I. labiatus*, Schl., and *I. Cuvieri*, Sow.; whilst the Turonian *I. Brongniarti*, Sow., is another branch, and *I. striatoconcentricus*, Gümbel, of the same stage, is in the straight line of development. In the Senonian, or Upper Quader and Upper Chalk, *I. planus*, Münster, and *I. Cripsi*, Mantell, continue from the *Cuvieri*-branch; and *I. Lamarcki*, Park., from the parallel *Brongniarti*-branch; and all point towards the highest, namely, *I. involutus*, Sow.

SOME GIGANTIC FOSSIL MAMMALS.—Among the huge fossil mammals obtained from the Lower Tertiary beds of Wyoming, the *Dinocerata*, Marsh, are very remarkable. The long narrow cranium bears three pairs of horn-cores, rising one pair above another, from the low nasal pair, to the higher conical maxillary pair, and to the posterior highest and broadest pair, which may have borne expanded and possibly branching antlers. These last horn-cores slope down in front into a pair of lateral coronal ridges, dominating over the great temporal fossæ. The attenuated nasal bones overlap a deep narial cavity. The premaxillaries are slender and toothless. In each maxillary is a great canine tooth, long, sharp, and decurved, with their roots running up into the middle horn-cores. Six small premolar and molar teeth on either side, with transversely ridged crowns, form another peculiar feature in this wonderful beast. Already various specimens, representing parts of the skeleton of several species of this genus, appear to have received different generic names—as *Loxolophodon*, Cope; *Uintatherium* and *Uintamastrix*, Leidy; *Dinocera*, Marsh; *Eobasileus*, Cope. Of their relative claims to priority and use, Prof. Marsh treats in the illustrated reprint before us, from "Americ. Journ. Sc." for Feb., 1873, p. 117, published in advance Jan. 28, 1873.

In his *Anniversary Address* to the Royal Society of New South Wales, May 22nd, 1872, the Rev. W. B. CLARKE, M.A., F.G.S, etc., gives a valuable summary of facts and opinions relating to the natural history of the diamond and diamond fields in Brazil, South Africa, India, and Australia, in amplification of the very useful observations he offered on the same subject in his Anniversary Address of May 25th, 1870 (1871). T. R. J.

REVIEWS

I.—THE ERUPTION OF VESUVIUS IN 1872. By Professor LUIGI PALMIERI, Director of the Vesuvian Observatory. With Notes and an Introductory Sketch of Terrestrial Vulcanicity, etc., by ROBERT MALLET, Mem. Inst. C. E., F.R.S., F.G.S., etc. With Illustrations. Imp. 8vo. pp. 148. (London: Asher & Co., 1873.)

AS the particles of ashes, sand, and gravel contribute with the scoriæ and lava to build up the cone of Vesuvius, so, by the aid of larger type and leaded lines, Prof. Palmieri's modest little pamphlet on the eruption of 1872 has been built up into 58 pages, over which the translator has poured forth 78 pages of his own ideas and theories by way of introduction, concluding with a substratum of eight pages of notes.

We do not wish it to be supposed for a moment that we undervalue the almost heroic labours of Prof. Palmieri, as with patient care and untiring attention, he watches and records the varying indications of volcanic energy, denoted by the seismograph and electrometer, in his Observatory on the Crocelle, a part of the old buttress-wall of Somma, by Vesuvius, even, as on the terrible night of the 26th of April, 1872, when "the Observatory lay between two torrents of fire, which emitted an insufferable heat," so that "the glass in the window-frames, especially on the Vetrana side, was hot and cracking, and a smell of scorching was perceptible in the rooms." (p. 90.)

Prof. Palmieri's report furnishes many very interesting details not heretofore recorded. For example, the very diverse characters of the lavas of 1871 and 1872. The former (1871) is characterized by Prof. Palmieri as a "lava with a united surface." Mineralogically it is "rich in leucite, and containing little or no pyroxene." The latter (1872) is described as a "lava whose surface breaks up on cooling into fragmentary scoriæ;" its constitution shows it to be "poor in leucite and rich in pyroxene."

It is certainly remarkable that lavas so very different, both in mineral constitution and external aspect, should have flowed out of the same volcano within a few months of each other. Such rapid changes in the products of the same vent prove incontestably the great amount of change, both mineralogical and chemical, that is continually going on in the subterranean laboratory at no great distance from its outward opening.

"These (1872) lavas (says Palmieri) carried along in their course a quantity of scoriæ which had long been subjected to the action of the acids of the fumaroles close to the craters; and also many bombs—round masses similar to those ejected from craters—some having a diameter of 4 to 5 metres. These bombs must have flowed out with the lava, for they are found through its whole course, and masses so enormous were not thrown up from the craters during the eruption; those lying on the cone near the craters seldom exceeding a decimetre in diameter." (p. 105.)

This also is a singular and not very intelligible fact. Volcanic bombs, properly so called, are drops or masses of liquid and incandescent lava, launched from the surface of the molten mass in the crater by its gaseous explosions, and rounded by the resistance of the air as they ascend and descend again, just in the same way that drops of molten lead are rounded into shot by their fall from a 'shot-tower.' But this mode of formation would not account for spherical masses of such vast size as Professor Palmieri describes, enveloped in the flowing lava. The origin of these masses, which can hardly be true 'bombs,' deserves more careful investigation. Perhaps they are only spherical concretions, such as are not unusual in cooled lavas.

Another interesting point connected with this eruption was the quantity of sea-salt (chloride of sodium) evolved in the vapours and brought down with the rains, so that "not only the Vesuvian cone, but the whole adjacent country, appeared white for many days, as if covered with snow when exposed to sunlight." (p. 97). "The destruction of land in occupation of buildings and of crops exceeded three million francs in value." (p. 98.)

The five woodcut-plates of Vesuvius, copies of photographs of the cone,—four of them taken from the same point of the Observatory,—before and after the eruption, are too obscure and rude to tell much as to the change of form and height in the mountain, which are matters of some importance, and ought to have been verified by careful and frequent barometrical and trigonometrical observations. If Prof. Palmieri, with his single assistant, and the two Priests, "entrusted with the festive mass for the Observatory," cannot carry out this simple work, surely there are sufficient learned and scientific bodies interested in it who would willingly contribute the needful additional funds, to record such changes in the cone as must have been occasioned by so notable an eruption as that of 1872.

Mr. Robert Mallet's Introduction has really no connection with Palmieri's Report. It is partly occupied with a statement of his views on earthquakes and volcanoes, or, as he is pleased to call it, "Vulcanicity," and partly is made up of an exposition of his theory of the dynamics of volcanic energy, as set forth in his paper communicated to the Royal Society last year.

What we chiefly object to in this portion of the volume, is the assumption on Mr. Mallet's part of a conscious superiority to others, and a freely-expressed contempt for all previous observers, especially for geologists, "few" of whom "even appear to realize how great and important are the relations of *Vulcanicity* to their science viewed as a whole." (p. 78.)

We fear Mr. Mallet, in making this remark, forgot at the moment the fact that Mr. Poulett Scrope and Dr. Daubeny—but especially the former—wrote on Volcanoes and their connection with physical geology so long ago as 1824-5, and Mr. Scrope has since frequently written thereon; many of his papers having appeared in this MAGAZINE.

Nor can the charge of neglecting this subject be brought against Lyell or Phillips, whose published works attest their full appreciation of its importance.

While objecting to most of the views of geologists, which, however, he frequently distorts, Mr. Mallet claims the character of physical truth for his own ideas.

The only one which appears original, or nearly original, in his theory is, that Volcanic heat and force is wholly evolved from the crushing of the subsiding solid shell of the globe under secular cooling.

Strange to say, Mr. Mallet wholly overlooks the fact that the secular cooling of a superheated nucleus already provides heat enough for volcanic purposes, so that to imagine another wholly different source of heat arising from the collision and crushing together of the broken fragments of the crust is quite superfluous. To imagine, in short, two sources of heat, when one, and a recognized one, suffices to explain all the phenomena, is most unphilosophical, especially in one whose claims to high consideration are mainly based upon his mathematical accuracy. On other, and especially on chemical and mineralogical grounds (as pointed out by Mr. David Forbes in "Nature," Feb. 6th, 1872, p. 261), Mr. Mallet's theory is not likely to meet with a ready acceptance.

Those who wish to read in English Prof. Palmieri's account of the 1872 eruption, will find the present edition—with the exception of some slight faults in translation, and a few errata in printing—serve their purpose excellently well; we should have preferred, however, to keep Mr. Mallet's Introduction distinct from Professor Palmieri's Report.

II.—Dr. C. W. Gümbel on the so-called "Nullipores," and their Participation in the Composition of Calcareous Rocks ("Die sogenannten Nulliporen," &c.). From the *Transactions* of the Bavarian Academy of Sciences, 1871 and 1872.

Of the many obscure fossils that pass from hand to hand among working palæontologists, waiting until a matured knowledge of nature assigns them to this or that group with certainty, the so-called "Nullipores" have been by no means the least vagrant; they have received as many synonyms as they have had observers. Bringing the microscope and an intimate knowledge of both microphytes and microzoa to bear on them, Dr. Gümbel, of Munich, resolves the known fossil "Nullipores" into two kinds—1. True calciferous Algæ (*Lithothamnium*, and an allied form *Lithiotis*); and, 2. Foraminifera (*Dactyloporideæ*). In the first category he describes (1871, pages 13–52, plates i. and ii.) :—

1. *Lithothamnium ramosissimum* (Reuss).—Middle Tertiary.
2. *L. nummuliticum*, Gümbel.—Lower Tertiary.
3. *L. effusum*, Gümb.—Lower Tertiary.
4. *L. pliocænum*, Gümb.—Upper Tertiary.
5. *L. tuberosum*, Gümb.—Lower Tertiary.
6. *L. torulosum*, Gümb.—Lower Tertiary.
7. *L. mamillosum*, Gümb.—Upper Chalk.
8. *L. Parisiense*, Gümb.—Lower Tertiary.
9. *L. Jurassicum*, Gümb.—Sponge-rock with *Ammon. bimammatus.*
10. *L. procænum*, Gümb.—Upper Chalk.

11. *L. perlatum*, Gümb.—Upper Chalk.
12. *L. asperulum*, Gümb.—Upper Tertiary.
13. *L. palmatum* (Goldf.).—Chalk.
14. *L. racemosum* (Goldf.).—Upper Chalk.
15. *L. Goldfussi*, Gümb.—Chalk.

1. *Lithiotis problematica*, Gümb.—Trias (Rotzo beds).

Dr. Gümbel also indicates several figured fossils, which probably have reference to calciferous Algæ.

The assorting and characterization of the second, or Foraminiferal, group of the so-called "Nullipores," a still more difficult task, has been accomplished in a masterly manner. With a comprehensive view of the chief features and group-characters of the *Dactyloporæ*, as described in Carpenter's "Introduction to the Study of Foraminifera," Dr. Gümbel took in hand the revision of the described forms, and the explication of several obscure organisms, from the Alpine Limestones, which he saw reason to associate with them. The results are published in the Second Part of his Memoir, 1872 (pp. 231–288), with four richly filled quarto plates. The following list is full of interest both to Geologists and Rhizopodists:—

I.—*Haploporella*, Gümbel.

1. *H. eruca* (Parker and Jones).—South Seas, and fossil at Grignon, &c.
2. *H. annulus*[1] (P. and J.).—Grignon, &c.
3. *H. reticulata* (Defr.).—San Domingo, Grignon, &c.
4. *H. scrobiculata*, Gümb.—Cuisse la Motte.
5. *H. biscutata*, Gümb.—Cuisse la Motte.
6. *H. vesiculosa*, Gümb.—Grignon, &c.
7. *H. glandulosa* (d'Arch.).—Biarritz.
8. *H. fasciculata*, Gümb.—Astrupp.
9. *H. digitata* (P. and J.).—Grignon, &c.
10. *H. marginoporella* (Michel.).—Loc. ?

II.—*Dactyloporella*, Gümbel. (=*Dactylopora*, Auct. *in parte*.)

1. *D. cylindracea* (Lam.).—Grignon, &c., and Belgium.
2. *D. saccata*, Gümb.—Grignon, &c.
3. *D. miocænica* (Karrer).—Banat, &c.
4. *D. elegans*, Gümb.—Dax.

III.—*Thrysoporella*, Gümbel.

1. *Th. cancellata*, Gümb.—Grignon, &c.
2. *Th. cribrosa*, Gümb.—Beauchamp.

IV.—*Gyroporella*, Gümbel.

1. *G. annulata* (Schafhäutl).—Wetterstein Limestone, &c.
2. *G. cylindrica*, Gümb.—Muschelkalk.
3. *G. dissita*, Gümb.—Wetterstein Limestone, &c.
4. *G. debilis*, Gümb.—Dolomite of Mendola (Muschelkalk ?).
5. *G. macrostoma*, Gümb.—Dolomite of Mendola.
6. *G. pauciperforata*, Gümb.—Limestone of Reifling, Reiss Alpe.
7. *G. minutula*, Gümb.—Reifling Limestone.
8. *G. Silesiaca*, Gümb.—Muschelkalk, &c.
9. *G. infundibuliformis*, Gümb.—Mendola Dolomite.
10. *G. triasina* (von Schauroth).—Muschelkalk, &c.

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[1] Probably the same as *Dactylina Fischeri*, Zborezewski, Bull. Imp. Nat. Moscou, 1843, vol. xvi., p. 363, woodcut. It is possible that Fischer de Waldheim's *Spirolina sulcata*, in the Carboniferous Limestone of Miatchkowa, "Oryctographie Moscou," 1830, pl. 12, fig. 3 *a*, *b*, *c*, may belong to the *Dactyloporideæ*.—T.R.J.

11. *G. multiserialis*, Gümb.—Mendola Dolomite.
12. *G. æqualis*, Gümb.—Wetterstein Limestone, &c.
13. *G. curvata*, Gümb.—Alpine Dolomite, &c.
14. *G. vesiculifera*, Gümb.—Alpine Dolomite, &c.

Two small problematical organisms, probably allied to *Gyroporella*, are also figured and treated of, namely :—

Cylindrella Silesiaca, Gümb, from the Muschelkalk; and *Uteria encrinella*, Michelin, from the Lower Tertiary beds of Cuisse la Motte, France.

The difficulty of working out the characters of these *Gyroporellæ* imbedded in hard limestones has been very great. Dr. Gümbel himself looks forward to still more complete results being obtained from continued research. Evidently, these organisms are to be looked for in other Jurassic and Cretaceous strata, besides the Neocomian Limestone of the Wetterstein: the *Verticellipora anastomosans*, and its varieties, in the Farringdon Beds, would repay the labour of careful examination by a Dactyloporist. The great difference between the Triassic forms (*Gyroporellæ*), without true "chambers," and the Tertiary *Haploporellæ* and *Dactyloporellæ* (with true "chambers") is very striking. But certain Tertiary forms (*Thyrsoporellæ*) approximate to the *Gyroporellæ;* and if the last be simple in some respects as to structure, nothing can be simpler in make than several of the latest *Haploporellæ*, mere rings or half-rings of adherent sacs.

That these little creatures have mightily aided in the construction of all limestones is of great interest to the Geologist; as lowly links of life they are worthy subjects of study for the Zoologist.

T. R. J.

III.—THE GEOLOGY OF THE LONDON BASIN.

MEMOIRS OF THE GEOLOGICAL SURVEY OF ENGLAND AND WALES, Vol. IV., Part I.—THE CHALK AND EOCENE BEDS OF THE SOUTHERN AND WESTERN TRACTS OF THE LONDON BASIN. By W. WHITAKER, B.A., etc. 8vo. London, 1872.

MANY a good deed passes unnoticed, and many a good work gets little praise. They are none the worse for that; and yet when heard of they become ensamples to many and good food for the healthy inquiring mind. Thus one of the most important geological publications of the past year was unostentatiously produced by Her Majesty's Stationery Office; and, not being announced in circulars and advertisements, it makes no noise, though a standard work and without a rival on its own ground. True it is, that practical geologists have had access to the maps to which it relates, and to their divisional Explanations appearing from time to time, and ultimately incorporated with the larger work,—and, more still, to the author-in-chief of this comprehensive book, and his colleagues, Messrs. Bristow and Hughes,—and thus, having benefited by foretaste and anticipation in the imparted knowledge, we forget to be grateful when all the store of hard-won information is at last put before us in a systematic form. The amount of general and special geological information amassed in this thick and well-illustrated official volume is enormous; and fully elucidates the structure of the largest and most important part of the London district, from near Marlborough to the mouth of the Thames. The Director-General, in passing this work for the press, truly says, "The numerous accounts of well-sinkings and borings, given in the Appendix, cannot fail to be of great economic value to many classes of the community; and other questions of geological economics have been carefully attended to. The bibliography of the whole subject, also, in the Appendix, forms a valuable contribution to geological science; and, indeed, the examination of this Appendix alone attests the extensive knowledge and scrupulous accuracy of Mr. Whitaker." We cordially indorse this well-deserved eulogium; and we feel assured that all who have recourse to this laborious and conscientious work on the Greensand, Chalk, Thanet beds, Woolwich and Reading beds, Oldhaven and Blackheath beds, London Clay, Bagshot beds, and "Kentish Crag," of the area under notice, will find themselves aided, as if by a willing and masterful guide.—T.R.J.

REPORTS AND PROCEEDINGS.

Geological Society of London.—I.—January 8, 1873.—Prof. Ramsay, F.R.S., Vice-President in the Chair.—The following communication was read:—"The Secondary Rocks of Scotland."—First Paper. By John W. Judd, Esq., F.G.S.

Introduction.—The Mesozoic periods are in Scotland represented only by a number of isolated patches of strata situated in the Highlands and Western Isles, which have been preserved from the destructive effects of denudation either through having been let down by great faults among the Palæozoic rocks, or through being sealed up under vast masses of Tertiary lavas. The Cretaceous rocks, exhibiting very interesting characters and yielding a beautiful series of fossils, were discovered by the author of the paper during the past year on the mainland and in several of the islands of the west of Scotland. The Jurassic rocks, which were first described by Murchison, are now shown to present a remarkable contrast with their equivalents in England, in being constituted, *throughout their whole thickness, by alternations of marine and estuarine series of beds*, in which respect they precisely resemble the equivalent strata of Sweden. The Triassic rocks have now been discovered in Sutherland, where their conformable relations to overlying beds containing a fine Liassic fauna, entirely confirms the conclusions concerning their age, derived from Prof. Huxley's studies of the remarkable reptiles yielded by them in Elgin.

Part I.—*Strata of the Eastern Coast.*—These consist of a number of patches, situated around the shores of the Moray Firth, in the counties of Caithness, Sutherland, Ross, Cromarty, and Elgin. The preservation of these is shown to be entirely due to the operation of faults of enormous magnitude, which have let down the Mesozoic strata against the various Palæozoic rocks. Owing to an insufficient examination of the palæontological evidence, much misconception has hitherto prevailed concerning the geological age of most of these patches; but a careful study of their faunas enables us to reconstruct an almost unbroken history of the Triassic and Jurassic periods in the north of Scotland; while even concerning the Cretaceous much important evidence is afforded by the boulders, which abound in the drifts.

The Keuper is represented by the Reptiliferous Sandstone and the overlying calcareous rocks; the Rhætic by conglomerates in Sutherland, and probably elsewhere by estuarine beds, which are now, however, only preserved in great boulders.

The Lower Lias is constituted in its lower part by a thick series of estuarine beds, sandstones, shales and coals (hitherto referred to the Lower Oolites); and in its upper part by marine strata, yielding a highly characteristic fauna. The Middle Lias is formed of clays seen *in situ* in Sutherland, and micaceous sandstones, only preserved in boulders; both furnish very fine series of fossils. The Upper Lias is probably represented by estuarine beds.

The Lower Oolites are almost wholly made up of estuarine strata, containing coal-seams, which have been frequently worked in the past in mines which are now being re-opened. The beds yield many freshwater fossils, which have attracted much attention, owing to the general resemblance they present to those of the Wealden.

Of the Middle Oolites we have a wonderfully complete series in the east of Scotland. At the base is a calcareous sandstone crowded with Kelloway fossils; above this 300 feet of shales, yielding the well-known Ammonites and other fossils of the "Ornatus-clays" (Middle Oxfordian); still higher are beds of marine sandstone with a magnificent fauna, identical with that of our Lower Calcareous Grit. A thickness of 400 feet of estuarine sandstones, etc., which covers the last, is surmounted by limestones, shales, and sandstones, with the fossils of the Coral Rag.

The Upper Oolites, now for the first time recognized in Scotland, are of great thickness, and consist of alternations of estuarine and marine strata, yielding a splendid fauna and flora. In their northern extension these beds pass into the wonderful "brecciated beds" of the Ord, which contain enormous transported blocks of Old Red Sandstone. The features presented by these strata are of the highest interest, and are very suggestive of the prevalence of peculiar physical conditions in the area towards the close of the Jurassic period.

The patches of Secondary strata on the coasts of Ross, usually called Lias, are shown to belong to the Lower, Middle, and Upper Oolites; and a mass on the coast of Elgin is demonstrated to be also of Oolitic age.

In future papers the author proposes to describe the Secondary rocks of the west coast and islands of Scotland, and to discuss the various theoretical questions suggested by a comparative study of the whole of the Scottish Mesozoic strata.

Discussion.—Mr. Etheridge commented on the amount of labour which had been bestowed by the author in examining the country described in the paper, and was quite prepared to accept his conclusions. He pointed out the analogies presented by the Scottish beds with those of Yorkshire, while at the same time their relation to the beds of Southern England was far more obscure. The estuarine characters exhibited in the Lias of Yorkshire were, however, absent in Scotland. Nevertheless the faunas of the Oolites in Scotland and in the South were so much the same that there could be no question as to the identity of their age. He complimented the author on the skill and energy he had displayed in investigating the history of these rocks, and inquired whether he had been able to work out the limits of any areas of deposition in connexion with the varied features of the Mesozoic beds of Scotland and the north of Europe, which seemed to have extended even as far as to Greenland. He inquired whether the author had himself found any remains of *Stagonolepis.*

Mr. Carruthers made some observations on the value of the observations on fossil botany which Mr. Judd had made in the Secondary beds of Scotland, which was enhanced by his being able to assign a definite position to the beds in which the plants were found. In Scotland, however, the vegetable life at certain periods of the earth's existence had now been discovered, though no evidence of its character was forthcoming in England, where the beds were otherwise well represented. He remarked on the discoveries of the late Hugh Miller, which, so far as Cycadeæ were concerned, had disclosed the existence of Secondary plants elsewhere unknown, but which had now been supplemented by the investigation of Mr. Judd.

Mr. Seeley commented on the variations in the distribution of land and water during the deposition of the various strata of which the British Islands are composed, and drew the inference that there had been a gradual change in the relation of the beds to neighbouring land which at one time existed to the West, then passed to the North, and finally to the East.

Mr. H. Woodward inquired whether in some instances where the author had regarded the beds as estuarine, he might not, with better reason, regard them as old land-surfaces, especially at the points where coal occurred.

Mr. Judd, in reply, regretted that he was unable to fill up the gap which appeared to exist between the Lower Oolites and the Middle Lias; but even in the drifts he had been unable to find any specimens of the Upper Lias fossils, which are so remarkable and characteristic. He therefore considered that the thick beds of sandstone might represent both periods. He thought that traces were to be found of different areas of deposition in different bays and estuaries during the Oolitic period. He had not himself found reptilian remains, which were always found by, or came into the hands of, Dr. Gordon. The coal of the district was principally made up of *Equisetum*; and though this was a water-plant, he considered the beds might with almost equal propriety have been called terrestrial as estuarine.

Prof. Ramsay, in conclusion, observed that it was well known that the Jurassic and Oolitic beds of Europe must have accumulated in a warm climate around islands and in bays and estuaries. It was, however, difficult to account for the rivers flowing over such narrow tracts of land as that represented by the central portion of the British islands, having had such important estuaries. The large transported blocks of Old Red Sandstone found in the conglomerates offered another difficulty. He agreed with Mr. Judd as to the impossibility of fixing the age of the main line of faults, as many of them might date back their origin to an earlier period than the commencement of the deposition of the Oolites. The narrow neck of land which intervened between the eastern and western Oolitic beds of Scotland offered great matter for consideration. With regard to the connexion between the Lias and Trias, he had long regarded the New Red Marl as more intimately related to the Lias than it was to the New Red Sandstone; and in Scotland the New Red Marl seemed to be absent, and the Lias to be brought into comparatively close contact with what was considered to be the New Red Sandstone.

II.—January 22, 1873.—His Grace the Duke of Argyll, K.T., F.R.S., President, in the Chair.—The following communication was read:—"On the Glaciation of Ireland." By J. F. Campbell, Esq., F.G.S.

The author stated that almost the whole of the surface of Ireland consists of glaciated rocks less or more weathered, or well preserved. The polished surfaces are covered in low grounds with drift. Boulder-clay, unstratified, is next to the rock; sands and gravels and peat bogs are above the clay. The solid rocks have been greatly worn away since the formation of the Antrim basalt; the drift since the Glacial period. The hills and hollows in the rocks are the result of wearing and "denudation;" the débris is the "drift" partially re-arranged.

This was shown by examples in,—1st, Chalk and basalt in Antrim; 2nd, Mountain-limestone, etc., in Sligo; 3, older rocks about Valentia and the south-west; 4, granites and metamorphic rocks in Donegal and the north-east. The effect of the Atlantic on cliffs at Slieve Liag in Donegal and elsewhere on the Irish coast was noticed.

It was shown from these large coast-sections that the upper surface now has no relation to the older contortion, fracture, and folding of these disturbed and faulted rocks, which lie under newer and less crumpled beds, up to the peat. The probable dimensions of the ice-engines which worked on the surface of Ireland was shown by comparison of glaciers in Iceland, Norway, and elsewhere, with the Irish marks, which indicate ice of equal size. Beginning with the smallest and rising to larger systems, Irish marks indicate ice of equal dimensions, till horizontal grooves at 2000 feet above the sea indicate ice more than 2000 feet thick, moving over Ireland into the Atlantic in a south-westerly direction. It was shown that the ice at its maximum probably extended from the Polar Basin to Cape Clear. In support of this view, boulders on Fairhead, and the denudation and glaciation of the central highlands of Scotland, and of Scandinavia, Finland, and the United States, were shortly noticed. The question whether these extensive tracts were made by glaciers or by icebergs was discussed. The marks in Ireland and Scotland seem to the writer to indicate ice more than 2000 feet thick moving along the bottom of lochs, straits, and shallow seas, in water less than 1800 feet deep, with large local ice-systems upon high lands. It was shown that glacier-ice aground in water is easier to push horizontally, and so to drive over impediments in proportion to the weight lifted vertically by flotation.

Rubbings from glaciated rocks placed beside shaded Ordnance maps of parts of Scotland and England, showed that similar forms had been somehow produced on scales of inches and miles upon the rock-surface of Scotland.

The author's conclusion is as follows:—

"Ireland has been greatly denuded. Glacial and marine action are the most powerful known to me. Glaciers and the sea shaped Ireland, as I believe. Rivers and weathering have done little to obliterate the tool-marks of ice and the sea since the end of the last of a series of Glacial periods."

Discussion.—Prof. Ramsay agreed in the main with the views of the author, and with the opinion of Agassiz as to the great extension of cold at a certain period both in the northern and southern hemispheres, though he could not carry the theory quite so far as to leave merely a narrow equatorial belt unaffected by ice. He had, however, never seen any mountain region in the northern hemisphere on which there were no traces of glacial action. As to Ireland, he knew of no portion of its surface which had not been glaciated, and the great striations actually extended, as they do in Scotland, right over the watersheds, and were evidently unconnected with any merely local features. At the same time, even where the general current of the upper portion of the ice was constant, yet there might have been and probably were, undercurrents, the course of which was determined by the form of the country traversed by the ice. He was not certain that the present features, resulting from denudation, were rightly attributed to glacial agency alone, as other causes appear to have been at work. He instanced cases of enormous denudation at early geological periods which it was difficult to trace to any glacial action. He thought that during the Glacial period the main features of the country were to some extent modified by the great ice-sheet which capped it, without its having had so extensive an effect as that sometimes attributed to it. Still sufficient changes had been made on the surface to cause the rivers which were resuscitated after the close of the Glacial period to take new courses. The existence of old river-valleys, partially obliterated by glacial action, proved to his mind that hills and valleys, and a diversified surface, existed previously to the Glacial period to almost as marked an extent as they do at the present day.

Sir Henry James observed that, having at one time been in charge of the Geological Survey of Ireland, he could endorse the views of the author as to the glaciation of that country, though he agreed with Prof. Ramsay as to the probability of valleys in Ireland and in Scotland having existed before the Glacial period, and guided the flow of the ice. These no doubt were intimately connected with the varying hardness of the rocks.

Mr. T. M'K. Hughes remarked that there was no necessity for a polar ice-cap from any secularly recurring cold, seeing that the difference of temperature, known as a matter of observation to be due to geographical causes, was so very much greater than any variation of temperature which had been shown to be possible owing to astronomical combinations, that the astronomical causes might be neglected. He showed that the glaciation which was relied on as a proof of the passage of large masses of ice from the north, did not appear to come from the north pole, but from local centres, such as Scandinavia, Scotland, and the mountains of Wales and the N.W. of England, from which the ice moved in all directions. He pointed out that the contents of the drift appeared to be ignored; for although in the British Isles the polar drift might have been pushed out to sea by later glacial action, still it would only have been transferred a little further on; and had any such drift been deposited generally over the north of Europe, traces of it ought to be found along the south and east margins of the Scandinavian drift. He appealed to the vast scale of the changes of level to which this part of the earth's crust had been subjected, and especially to the shell-beds of Moel Tryfaen and Macclesfield, to prove that changes of level of at least 1400 feet had taken place since the Glacial period, and inquired whether elevations on even that scale would not recall glacial conditions over a large part of the area under notice. He again proposed to the Society a question which he had asked several years before. What was the maximum pressure which ice would bear without becoming water or being crushed; and whether the consideration of this and the other conditions involved would lead us to assign a limit to the possible lateral extension and vertical thickness of an ice-sheet moving on a plain or uphill which would affect such speculations as that under discussion?

Mr. Mallet said that he was to some extent a disbeliever in glacial theories, though he had from an early period in his life noticed the scratched condition of much of the surface, and the presence of transported boulders in Ireland. He regarded, however, the main valleys traversing the island as of far earlier date, and due to the original form imparted to the land on its elevation, in consequence of lateral pressure. He thought that some portion, if not the whole of the striation, might be due to the slipping of the coating of detritus upon hard rocks, which would be the natural result of the elevation of a portion of the sea-bed covered with pebbles, sand, and mud. He thought the phenomena resulting from this cause could not be distinguished from those resulting from the operation of glaciers. If so, the effect generally attributed to glacial causes must be accepted with great caution. As to the limits to which ice would be capable of propagating its own motion, it had been found by experiment that a direct push could not be propagated through a mass of ice for any distance so great as a mile. He thought that this put an end to the view of valleys being excavated by ice, though, of course, if crushed, ice would still propagate its force laterally, and might produce certain effects. He denied that the results often attributed to grounding icebergs could be due to such a cause.

Mr. Evans disputed Mr. Mallet's conclusions as to the propagation of motion through ice and the effects of grounding icebergs.

Mr. Tiddeman had examined much of the western coast of England opposite to Ireland, and did not attribute its glaciation to any general ice-sheet radiating from the Pole. The glaciation in the valleys he regarded as of later date than that of the ice-sheet, and it was to be studied as a separate phenomenon. The ice-sheet he considered to have been general over the north of England, and its shed ran along the Pennine chain. Its tendency would be rather to form a series of parallel valleys than any radiating from a common centre.

Mr. J. Clifton Ward stated that in Cumberland he had found that the direction of the ice must, near Skiddaw, have been in a northerly direction.

The author, in reply, remarked that in Greenland, whatever might theoretically be the case, ice is pushed for scores or hundreds of miles down into the sea, until it gets out of its depth, and eventually floats off as icebergs. He pointed out the correspondence of the main valleys of Ireland with glaciations on the surface of rocks from Scotland, and exhibited specimens and rubbings in illustration of various characters of weathering and wear from different natural causes.

III.—February 5, 1873.—Warington W. Smyth, Esq., F.R.S., Vice-President, in the Chair.—The following communication was read:—"On the Oolites of Northamptonshire. Part II." By Samuel Sharp, Esq., F.S.A., F.G.S.

In the First Part of this Memoir the succession of beds in the neighbourhood of Northampton was shown to be as follows:

	Clay	Great Oolite.
	White Limestone	
	Clay with Ferruginous Band	
	("Upper Estuarine")	
	Line of Unconformity.	
Northampton Sand	Sand with Plant Bed	Inferior Oolite.
	("Lower Estuarine")	
	Variable Beds	
	Ironstone Beds	
	Upper Lias Clay.	

The Great Oolite limestone of this section has been confounded, even up to the present time, with a limestone (frequently Oolitic) which occurs between Kettering and Stamford, is prevalent about the latter town, and extends through Rutland and Lincolnshire (where it attains a thickness exceeding 200 feet) into Yorkshire; which limestone has been distinguished by Mr. Judd as the "Lincolnshire limestone." The object of the author was to show that these two limestones were distinct, and that while the former was of the Great Oolite period, the latter as certainly belonged to the period of the Inferior Oolite; and in citing evidence in proof of this position upon stratigraphical and palæontological grounds, he gave a general account of the geology of the northern division of Northamptonshire, illustrating his description by the exhibition of numerous fossils gathered from the various beds and localities referred to.

Between Northampton and Kettering, the Great Oolite limestone is the surface rock; and intersecting valleys upon that line, and the escarpment of the Ise valley, a mile east of Kettering, exhibit this sequence of beds:

Great Oolite	Limestone.	
,, ,,	Upper Estuarine Clays.	
Inferior Oolite	Lower Estuarine Beds	Northampton Sand.
,, ,,	Ferruginous Beds	
Upper Lias	Clay.	

And this section, with the successive superaddition of Great Oolite Clay, Cornbrash, Kelloway Rock, and Oxford Clay, is continued due east across the country to the valley of the Nene, and on into Huntingdonshire.

Upon the same Ise escarpment, about a mile north-east of Kettering, the thin end of the wedge of the Lincolnshire limestone is seen to come in; and this sequence, for the first time, is presented:

Great Oolite............	Limestone.	
" "	Upper Estuarine Clays.	
Inferior Oolite.........	LINCOLNSHIRE LIMESTONE (very thin).	
" "	Lower Estuarine Beds	Northampton Sand.
" "	Ferruginous Beds	
Upper Lias	Clay.	

The same sequence, with the occasional superaddition of the Great Oolite Clay, was shown to be repeated upon the western escarpment of the Ise, at Glendon, Barford Bridge, near Rockingham, at Weekly, and at Geddington (the Lincolnshire limestone increasing in thickness at every advance), and to occur over and over again upon innumerable escarpments in the counties of Northampton, Rutland, Lincoln, and York, offering unmistakable and incontrovertible evidence of the true stratigraphical position of the Lincolnshire limestone.

The author described the section in the ancient quarries at Weldon, whence is obtained the highly reputed freestone of that name. He exhibited a diagram of the horizontal section from Rockingham, on the Welland valley (which marks to the north-west the line of division between Northamptonshire and Rutland), through Weldon, by Oundle, and across the Nene valley into Huntingdonshire. It was shown by this diagram that, although the Lincolnshire limestone has a thickness of some 30 feet at Weldon, it thins out very rapidly eastwards, being nowhere found within three miles of Weldon in that direction, and being altogether absent from the Nene escarpment at Oundle, which presents, with this exception, the whole series of beds from the Oxford Clay to the Upper Lias Clay inclusive.

The author successively described sections in the Lincolnshire limestone—at Kirby, where the equivalent of the Colleyweston slate is quarried, this being the extreme western point at which it has been found; at Deene, Wakerley, Morcot (where the whole series from the Cornbrash to the Upper Lias inclusive occurs, the Lincolnshire limestone attaining to a thickness of 60 feet), Ketton (where the famous Ketton freestone is quarried), and Colleyweston. At the last-named place the well-known calcareo-arenaceous slate has been quarried for more than 350 years; and the numerous quarries occupy an area exceeding a mile in diameter. Here everywhere may be noted the position of this slate-bed, which bases the Lincolnshire limestone series, and immediately overlies the Lower Estuarine Sands.

Some three miles north-east of the Colleyweston slate quarries is the high ground of the Stamford Open Field, the summit of which is about 200 feet above the level of the river Welland. In this one hill-mass occurs (and may be observed) the whole series of beds from the Cornbrash to the Upper Lias inclusive, the Lincolnshire limestone having reached a thickness of 75 feet, and being the most important bed of the section.

The limestone which occurs beneath the Great Oolite Clay and above the Upper Estuarine series high up upon the escarpment of Stamford Field, occurs also, at a level some 100 feet lower, at Belmisthorpe, and at Danes' Hill and Essendine, in cuttings of the Great Northern Railway, the only record of the sections of which is to be found in Professor Morris's paper in the Society's Journal for 1853. This limestone was not formerly considered to be Great Oolite at all; but the author showed, by a comparison of the whole group of fossils obtained from both beds, that this limestone was identical with the Great Oolite limestone of the Northampton district.

The author described the peculiar effect of a fault occurring south of the Welland at Stamford, by which the Upper Lias capped by the Northampton Sand has been thrown up to an elevation overtopping the town. Upon a severed and subsided mass the important suburb of St. Martin's has been built, and a peculiar repetition of beds has resulted—Upper Lias, Northampton Sand, Colleyweston Slate, and Lincolnshire Limestone being in a double sequence encountered upon an ascent of the escarpment. The fact was stated that the Colleyweston slate was found near the foot of the escarpment (whence the beautiful *Astropecten* var. *Stamfordensis*, Wright, was obtained by the author in 1853), and again upon the summit of the escarpment, at a distance of one third of a mile, at an increased elevation of 150 feet. Other anomalous results of the same fault, which extends some miles eastward, were described.

The area of the old "Barnack Rag" quarries was referred to. These were in work in the time of the Romans, but had been exhausted for 400 years. The stone (Lincolnshire limestone) was the building-stone over a large district in ancient times, and its excellence was proved by time.

The escarpment south of the Nene valley at Wansford presents the same sequence as that of the Stamford Field—Cornbrash to the Upper Lias inclusive. The railway-tunnel is excavated in the Lincolnshire limestone. East of this, at Castor and Water Newton, and west of the same point at Elton, the Lincolnshire limestone thins away, and the two estuarine series again come together in vertical contact. Along the Nene valley towards Northampton the southern escarpment presents the complete sequence of beds from the Oxford Clay to the Upper Lias inclusive (*minus the Lincolnshire limestone*), as far as Thrapstone. Here the Oxford Clay and Cornbrash part company and trend southward, the other members of the series (Great Oolite Clay and limestone, Upper Estuarine, Lower Estuarine and ferruginous beds of Northampton sand, and Upper Lias) continuing on to the Northampton district.

The author contended that the stratigraphical and palæontological evidence combined to establish the position which he assumed in his introduction—that the Great Oolite limestone of Northampton was identical with what he considered was Great Oolite at Stamford, and that the "Lincolnshire limestone" was a distinct formation, and a member of the Inferior Oolite series.

He had confidence that he had shown that the series of beds in the north-eastern portion of the northern division of Northamptonshire comprised all the beds between the Oxford Clay and Upper Lias inclusive, *including the Lincolnshire limestone;* and that those of the south-western portion comprised the same sequence, *excluding the Lincolnshire limestone.*

He considered that the Great Oolite Clay represented the Forest Marble and the Bradford Clay of the West of England; that the Great Oolite limestone was nearly equivalent to the Great Oolite of Bath and the Cotteswolds, and to the upper beds of Minchinhampton; that the Upper Estuarine might be nearly identical with the Upper Plant Shale of Yorkshire, but more certainly with the Stonesfield slate of Oxfordshire; that the Lincolnshire limestone was nearly synchronous with the grey limestone of Yorkshire (Inferior Oolite), and probably with the lower portion of the *Am. Humphriesianus* zone of the west of England, but extending a little below this zone; that the Lower Estuarine answered to the Lower Plant Shale of Yorkshire, but had no representative in the west; that the upper portion of the ferruginous beds of the Northampton Sand was nearly upon the same horizon as the Glaizedale and Dogger beds of Yorkshire and the *Am. Murchisonæ* zone of the west; and that the lower portion of the Northampton Sand was represented by the *Am. opalinus* zone and the Midford Sand.

Discussion.—Mr. Etheridge expressed his obligation to the author for his paper, and for the remarkable collection of fossils he had exhibited. The ground over which he had worked was one the features of which had required a great amount of well-directed labour to decipher. He considered, however, that Mr. Sharp and Mr. Judd had settled the question of the sequence of these rocks, and their relation to the Oolitic beds of Yorkshire to the north, and Gloucestershire to the west. The importance of the determination of the position of a bed of such commercial value as the Northampton sands could hardly be over-estimated; and it was to Mr. Judd and to the author that this determination was due. It had, moreover, been attained under very adverse circumstances; for at the time when the Survey of the district had been undertaken, the Lincolnshire limestone had not been recognized; and even Prof. Morris had at first failed to see that this bed intervened between the Northampton sand and the Great Oolite. It was mainly due to the extensive collection formed by Mr. Sharp that the key to the existence of this important bed and of the geological history of the whole district during the Mesozoic period was discovered. The mapping of the country was not to be effected by studying merely its lithological characters, but was mainly dependent on a knowledge of the palæontological features of each of the successive beds. Mr. Etheridge pointed out the close correspondence between the position of the Northampton beds and those of Yorkshire, with the exception of the absence of the Great Oolite in the latter area Though the Stonesfield slates and the Collyweston beds were so similar in lithological character that even the most experienced might take the one for the other; yet, when the organic contents came to be examined, the difference became evident; and in Mr. Sharp's paper stratigraphical evidence had been brought to corroborate the palæontological, and to show conclusively the difference in the horizon of the two beds.

Mr. Judd could not over-estimate the value of Mr. Sharp's labours, extended, as they had been, over nearly a whole lifetime. They afforded another instance of the great value of local inquiries in geology. It was becoming more and more evident that the sequence of beds which held good for one place required some modification in another; and that in each case there was a more or less distinct local series, showing that in no one locality was the sequence absolutely perfect, as indeed had been already pointed out by Mr. Darwin.

Mr. Charlesworth remarked on a specimen of the teeth of the genus *Lepidotus* exhibited, consisting of cylindrical columns surmounted by a conical crown, which struck him as one of unusual interest in the magnificent collection displayed. He commented on the value of such local collections for palæontological purposes, and on the necessity of their being formed if the progress of geology was to be furthered.

Prof. Duncan also was highly impressed with the value of Mr. Sharp's collection. He remarked on two specimens of Madreporaria, one of which, *Thamnastræa concinna*, presented a series of ridges significant of intermittent growth. The other form presented a strange relic of Palæozoic coral forms, being intersected by tabulæ like those of ancient times. It afforded an instance of a tabulate Actinozoon, in opposition to the opinion of Agassiz that the Tabulata belonged to the Hydrozoa. Both species grew on narrow bases; and though not reef-corals, were forms such as were to be found in the neighbourhood of reefs. Taken in conjunction with the Saurian remains, he thought they were symptomatic of shallow sea conditions, such as those existing between the continent of America and the West-India Islands.

Mr. H. Woodward contrasted the collections formerly exhibited to the Society with the grand series now shown by the author, inasmuch as in former times the same amount of regard had not been paid to the stratigraphical position of the specimens, and their value was in consequence almost destroyed.

Mr. Sharp, in reply, mentioned that some portion of his collection had been formed by Mr. Bentley, and not by himself, and that therefore he could not claim the credit of the whole. He was gratified to find that there was so little disagreement with his conclusions.

The Chairman, in conclusion, expressed his satisfaction at the fact that, notwithstanding the existence of the Geological Survey, there was still room left for individual discovery and research, which in this instance had served to rectify what might have been erroneous views on the part of the Survey.

IV.—The Anniversary Meeting of the Society was held on Friday, the 21st of February. His Grace the Duke of Argyll, K.T., President, in the Chair.

The finances of the Society were reported to be in a highly satisfactory state.

The Wollaston Gold Medal was awarded to Sir Philip de Malpas Grey Egerton, Bart., M.P., for his eminent services to Palæontological Science, and particularly in recognition of his researches in Fossil Fishes.

The Balance of the Wollaston Fund was awarded to J. W. Judd, Esq., F.G.S., in aid of his investigation into the Geology of Sutherlandshire, etc.

The First Murchison Bronze Medal (together with a part of the Fund) was awarded to Mr. William Davies, of the British Museum, in recognition of his long and valuable services, rendered, during a period of thirty years, to the cause of Palæontological Science.

The Balance of the Murchison Fund was awarded to Prof. Oswald Heer, of Zurich, in aid of his researches into the Miocene Flora of Arctic Europe, Greenland, and America.

The Anniversary Address was delivered by His Grace the Duke of Argyll, as President, in which he ably controverted the theory of a Polar Ice-cap extending to the South of Europe and contended that even the powers of Glaciers to cut out valleys and excavate lake-basins had been vastly over-estimated, and argued that the valleys down which the Glaciers flowed existed before the Glaciers occupied them.

Royal Geological Society of Ireland.—Dublin.—The annual general meeting of this Society was held in the Museum of Trinity College, on Wednesday, 12th February, when the President, Professor Alexander Macalister, M.B., read his address; and the following officers for the incoming year were elected:—*President:* Professor Edward Hull, M.A., F.R.S. *Vice-Presidents:* Earl of Enniskillen, F.R.S.; Col. M. Taylor; Alexander Macalister, M.B.; Rev. H. Lloyd, Provost, T.C.D.; Sir Richard Griffith, Bart., LL.D. *Treasurers:* William Andrews, Esq.; Samuel

Downing, LL.D. *Secretaries:* Rev. S. Haughton, M.D., F.R.S.; Prof. Ramsay H. Traquair, M.D. *Council:* Sir Robert Kane, F.R.S.; Alphonse Gages, M.R.I.A.; B. B. Stoney, C.E.; W. Frazer, F.R.C.S.; Alexander Carte, M.D.; W. H. S. Westropp, M.R.I.A.; C. R. C. Tichborne, M.R.I.A.; Rev. Maxwell Close, M.A.; Francis M. Jennings, F.C.S.; John Ball Greene, Esq.; William H. Baily, F.G.S.; William Ogilby, F.Z.S.; R. A. Gray, C.E.; J. Emerson Reynolds, M.D.; Edward Hardman. From the statement of the Treasurers, it appeared that the financial condition of the Society was highly satisfactory. The thanks of the Society to the President for his very able address were moved by Col. Meadows Taylor, and seconded by the Rev. Maxwell Close, and cordially agreed to by the Meeting.

Geologists' Association.—I.—The annual general meeting was held on Friday, February 7th, at University College, the Rev. T. Wiltshire, M.A., F.G.S., the retiring President, in the Chair.—The report for 1872 shows that by educational field-meetings, as well as by the papers published in the *Proceedings*, the Association has been the means of imparting a considerable amount of geological knowledge to the members, many of whom are earnest students of Geological Science. Henry Woodward, Esq., F.G.S., F.Z.S., etc., etc., was elected *President* for 1873; and R. Etheridge, Esq., F.R.S., etc., etc., Prof. Morris, F.G.S., J. Thorne, Esq., F.S.A., and the Rev. T. Wiltshire, M.A., *Vice-Presidents.* Messrs. U. Hislop, J. L. Lobley, and A. Bott were re-elected *Treasurer*, *Hon. Secretary*, and *Hon. Librarian* respectively. The Rev. T. Wiltshire, M.A., was elected an Hon. Member in recognition of his early services to the Association, of which he was one of the founders, and a cordial vote of thanks was given to Mr. Wiltshire for his services as President during the past two years. Votes of thanks to the other officers of the past year and to the auditors terminated the proceedings.

II.—February 7th, 1873.—Henry Woodward, Esq., F.G.S., F.Z.S., President, in the Chair.—"On the Diprionidæ of the Moffat Shale," by Charles Lapworth, Esq., F.G.S.

After reviewing the history of investigation among the biserial graptolites, and the antagonistic opinions regarding their internal structure held by different palæontologists, the author stated that a careful decomposition and examination of specimens, of *Climacograptus* from the Moffat shale, preserved in a state of relief, had forced him to the conclusion that the view of the duplicate nature of the polypary in this genus advocated by Prof. Nicholson is substantially correct. The internal characters are identical with those of *Diplograptus.* The diprionidian polypary is composed of two distinct monoprionidian polyparies (each having its own cænosarc, virgula, and separate hydrotheca) placed back to back and coalescing along their flattened dorsal walls. There is certain evidence that this type of structure obtains among all, or nearly all, the Moffat *Climacograpti.* Nevertheless he was not prepared to deny the accuracy of Prof. Hall's interpretation of the internal characters of his *Climacograptus ? typicalis.* As long as a doubt remained upon this point it was argued that it would be unsafe to exclude *Retiolites* and its allies from the *Diprionidæ*, which might meanwhile be considered as embracing three such families, viz. *Diplograptidæ*, *Retiolitidæ*, and a third and intermediate sub-family of which *Clim. ? typicalis* (H.) is the only known example. The sub-family *Diplograptidæ* will include all those species at present referred to *Diplograptus* and *Climacograptus.* Now that the type of structure in these two genera has proved to be identical, a new classification is necessary. The only remaining characters that can in all cases be employed for the purpose of separation at our command are, the form of the polypary and the shape and arrangement of the hydrothecæ. It was shown that the different species of the Diplograptidæ naturally arranged themselves into five groups, clearly individualized by striking distinctions in these characters. Each of these groups it was contended was of sufficient importance to be considered as forming a separate genus. In this way the genera *Climacograptus* (Hall), and *Cephalograptus* (Hopk.), would remain untouched, and the author suggested that the generic term *Diplograptus* (M'Coy) should be restricted in future to those species of which *Dip. folium* (His.) is the type, and proposed two new genera, viz. *Orthograptus* to include those species resembling *Diplogr. quadrimucronatus* (Hall), and *Glyptograptus* for those found after the pattern of *Diplogr. tamariscus* (Nich.)

The second portion of the paper was devoted to a revision of the genera and species of *Diplograptidæ* found in the Moffat shale, and the following new species was described:—

Orthograptus aculeatus
,, *Carruthersi.*
,, *basilicus.*
,, *Pageanus.*
,, *explanatus.*
,, *compactus.*
Glyptograptus gregarius.
,, *per-excavatus.*
,, *modestus.*

Climacograptus styloideus.
,, *tubuliferus.*
,, *longicaudatus.*
,, *Wilsoni.*
,, *antiquus.*
,, *brevicornis.*
,, *mirabilis.*

CORRESPONDENCE.

NUMMULITES IN JAVA.

Sir,—In the Geol. Mag., No. 102, p. 561, Herr Verbeek is quoted as expressing a belief that the Nummulitic Formation would probably be found in Java and in most of the islands of the Indian Archipelago, as well as in Borneo, where he found both known and new species of *Nummulina* and *Orbitoides*. In a flint implement from Java I have lately seen several small *Nummulinæ*, probably the same as *N. Pengaronensis*, Verbeek; thus realizing Herr Verbeek's expectation. T. R. J.

THE DIVINING-ROD.

Sir,—May I add to what has already been said concerning the divining-rod, that belief in its powers is not confined in Cornwall to the ordinary miner. Men whose scientific merits are generally acknowledged have in some cases more than a bias in its favour. I found it the other day in use in the North of Devon, for the purpose of tracing iron lodes. According to Pryce—"Mineralogia Cornubiensis"—it was first introduced into Cornwall by Cooksworthy, the founder of the China clay trade, who learnt its use from a Spaniard, then in command of the garrison at Plymouth, named Riviera.

3, Patna Place, Plymouth. R. U. Worth.

GEOLOGISING ON THE COTTSWOLDS.

Sir,—During the last two years I have been supplied by quarry men with fossils from two quarries worked in the upper beds of the Great Oolite, and the finds have been so numerous and remarkable that I thought Geologists generally, and especially those located on the Oolites, would like to know the results. I only propose to give a general description of the fossils, some of which appear to be new, especially the corals, very few of which have been drawn or described. The quarries are located near Cirencester, and contain similar beds of Oolite, and are severally 400 to 450 feet above the sea. In one is a considerable fault, and in both, at times, is brought to light a close vertical fissure, the faces of which are scored *horizontally.* Denudation has carried away 12 beds of rock, together *28 feet in thickness,* and the uppermost bed must be that on which the Forest Marble reposes. The quarries have been excavated about 15 feet below the surface, and are composed of 4 feet soil and moved rock; then one bed, 3 to 4 feet thick, of exceedingly hard stone, the surface of which is flat, and on it large oyster-shells; next, three beds of stone; and lastly, a coral bed of about 4 feet in thickness. The coral bed has been disturbed, but in its recent state must have been a beautiful sight, from the number, variety, and beauty of forms and colours. I have already had upwards of 40 species brought me, and such as might supply materials for a complete local coral history. After the depression of the reef below the warm surf of the Oolitic Sea, it was flooded with Oolitic matter, and the corals have to be extracted from the mass, and much work required to clean them, and specimen after specimen examined, before the characteristic form of the species can be determined. I have already *sixteen* species whose growth was by stems, varying from 3 to 60 on an inch square of surface; the calices on which number from 40 to 140 on an inch; *ten* that are superficial corals, and once formed the coats of mollusks, the body of which has been decomposed, and a cavity left, more or less filled with crystals of carbonate of lime; I have *also twelve* corals which formed a solid mass of coral marble, on which life existed only on the surface; and *four* that show a growth in bands of coral marble; one of these retains its purple colour. The reef formed by these corals must have extended many miles; upon it was drifted fruits, as nuts and stems, and after its depression a great variety of univalves, bivalves, saurian vertebræ, and eggs, and teeth, and teeth of fish, and portions of crabs. Although I have known one of the quarries for many years, yet at most I only obtained three or four corals from it; but now that I depend on workmen who break up the bed, it is impossible to say how many more new species may be brought to me. THOS. C. BROWN.

FURTHER BARTON, CIRENCESTER,
6th January, 1873.

THE OLDEST KNOWN BRITISH TRIGONIA.[1]

SIR,—Having read some time ago, Mr. Ralph Tate's notice about the oldest known species of *Trigonia*, in the GEOLOGICAL MAGAZINE for July last (see p. 306), and the reference to a specimen from Marske (not *Maroke*, as there printed in error), in the York Museum, I desire to say that the latter is not from the Marlstone at all, but is an undoubted Inferior Oolite Fossil, the matrix being in all respects similar lithologically to the Dogger of the Peak, near Scarborough.

This leads me to doubt the whole affair, and to contend for the ancestral honour so long awarded to *Trigonia literata* (or *littorata ?*) of the Upper Lias. JOHN LECKENBY.

SCARBOROUGH, *January* 18, 1872.

PRINCIPAL DAWSON AND OTHERS ON MORAINES.

SIR,—As the reviewer of Dr. Dawson's *Post-Pliocene Geology of Canada* in your January Number scarcely did justice to the author on some points, you would oblige by finding space for a few remarks.

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[1] This letter was *accidentally omitted* last month.—EDIT. GEOL. MAG.

[illegible] Dr. Dawson in con- [illegible] of the Canadian [illegible] found in the world, [illegible] marine drift seem [illegible]

[illegible] and sea-beds as they [illegible] of the resultant [illegible] which we are now [illegible] Few men, I should [illegible] the accumulations [illegible] coasts of British [illegible] to trace the [illegible] districts [illegible] phenomena to [illegible]. Instead of invoking a [illegible] Dr. Dawson is illustrating the great [illegible] during the last [illegible]. Dr. Dawson admits the former [illegible] but he does not forget [illegible] we are now giving [illegible] associated with Canadian [illegible]

[illegible] of Canada was first [illegible] many facts revealed [illegible] would seem to point to deposi- [illegible]

[illegible] positions in which [illegible], while in form and [illegible] with which we are [illegible] mound a moraine [illegible] geologists, the following [illegible].

[illegible] in this **Magazine**) [illegible] never contain smoothed or [illegible] characterizing what in his day was called [illegible]

[illegible] in his *Antiquity of Man*, states that in the present [illegible] one stone in several thousand is glacially [illegible] and that in the case of fragments of ser- [illegible] moraines of Zermatt, etc., only one in [illegible] glaciated.

Professor Ramsay has repeatedly observed that it is sometimes [illegible] to distinguish moraine matter left on the land from moraine matter deposited in the sea.

According to Professor Nordenskiöld (see recent articles in the Geol. Mag.), moraines are scarcely ever met with in Greenland; and it has been stated by eminent Scandinavian geologists that terminal moraines are rare in Sweden.

The Rev. M. H. Close and Mr. Kinahan, in their most elaborate pamphlet on the *Glaciation of Iar-Connaught*, believe that the rarity of [illegible] of local glaciers in Ireland is an indication that the movements of the general ice-cap were somewhat quickly brought to an end by the submergence of the still ice-covered country in the sea. I have made a similar suggestion as explanatory of the wonderfully little moraine matter (distinct from pinnel or possible iceberg droppings) to be met with in the Lake District (Geol. Mag., Sept. 1872).

Nothing perhaps is more calculated to teach young geologists to hesitate before pronouncing a drift-mound to be a moraine, than the fact that the "practised eye" of a very great Glacialist, many years ago, led him to regard the intensely marine-bedded sand and gravel knolls around Carnforth as moraines.

In the above remarks the term moraine is used in its customary or Swiss acceptation, and not as including deposits of Boulder-clay, Till, or Pinnel. D. Mackintosh.

AMERICAN LAKE BASINS AND ARCTIC CURRENTS.

Sir,—While I am much gratified by the not unfriendly review of my Post-Pliocene Geology of Canada in your January Number, I may perhaps be permitted to explain briefly one point of some geological importance which I appear not to have stated with sufficient clearness. I refer to the apparently contradictory statements that the basins of the great American Lakes were cleaned out by cold Arctic currents, and that these basins are parts of old valleys communicating with the sea, and which may have been excavated by subaerial denudation. There is really no contradiction; and as the nature of our lake-basins is often misunderstood abroad, it may be well to put the facts of the case plainly.

It is well known, and may be seen by a mere glance at Sir William Logan's beautiful Geological Map of Canada, that the basins of the Great Lakes of the St. Lawrence are hollows of denudation, excavated in the softer members of the Silurian and Devonian rocks. But until attention was directed to the matter by Newberry and Hunt, it was not so generally known that they are connected with each other and with the sea by deep valleys, now filled up with Post-pliocene deposits, and which have not been re-opened by the modern rivers. Nor has sufficient attention been directed to the fact that the old Post-pliocene filling remains on the "lee" or south-west side of the Adirondacks and Laurentide ridge, while it has been cleaned out, if ever deposited to the same extent, opposite the gap of the St. Lawrence valley, and the depression north of the Laurentides, leaving the basins of the five great lakes in their present form.

These facts imply that the original rock excavation is of "pre-glacial" date, and in part at least referable to the epoch of continental elevation in the Tertiary period; and that the subsequent partial cleaning out of the sediment or preservation of the basins in an unfilled state, was due to oceanic currents flowing from the north-east, and having the same powers of erosion and deposition now possessed by the Arctic currents off the American coast.

In short the original rock excavation may have been a process of atmospheric denudation, finished in the Pliocene period. The subsequent filling and cleaning out belong to that action of the northern currents which, [illegible] with the disintegrating power of frost [illegible] northern land, has been [illegible] great and continuous trans[illegible] towards the temperate and [illegible] largely instrumental in [illegible] arguments, and has been [illegible] materials of Post-pliocene [illegible] and conglomerates that [illegible]

[illegible] of the modern Arctic currents [illegible] materials [illegible] by sub[illegible] [illegible] the recent [illegible] of the United States [illegible] in Silliman's Journal [illegible] With reference to the St. [illegible] the bottom on the edge of [illegible] and broken shells, and that [illegible] with that found in the Bay of [illegible] currents.

[illegible] deny the existence of [illegible] America in the Post-pliocene [illegible] continental glacier covering the [illegible]

J. W. Dawson.

[illegible] WYRE COAL-FIELD.

[illegible] of the Carboniferous deposits [illegible] published in the [illegible] Aug. 1871, I endeavoured [illegible] there was a patch of the older [illegible] coals allied to the lower [illegible] underlying the Upper Coal-measures [illegible] of Wyre Coal-field. The extent [illegible] is a matter of some importance [illegible] It can only be ascertained [illegible] boundaries are all [illegible] I do not expect that it [illegible] of older coal-measures, as are [illegible] Coalbrook, but it may [illegible] of many hundred acres [illegible] believe that it extends under [illegible] with a communication from Mr. [illegible] from which it appears [illegible] at about 250 yards east of [illegible] at a depth of 160 yards. [illegible] time, which I shall be [illegible] of your readers. Mr. Birchley [illegible] a white rock, very hard, and [illegible] of crystal-like substance, which the sinkers call [illegible] This rock was about 29 yards thick, and under it clunch and a rider coal (sulphur), about 9 inches thick; then more clunch, etc., and at about 88 yards a stratum of sulphur coal, of very good quality of its kind, and more than a yard thick. We then had many different measures of clunch clay, etc., etc., and several rocks, and then the measures were:

	FT.	IN.
Rider of Smut Coal	0	4
Brown Fireclay	2	0
Grey Rock	24	0
Strong Blue Binds	12	0
Dark Fireclay	5	0
Bat	1	6
Batty Coal	1	0
Smut Coal (very good)	4	0
Brown Clod, with light-coloured balls of Ironstone	5	0
Smut Coal	2	0
Black Clod, with dark-coloured balls of Ironstone	5	0
Smut Coal (good)	3	4
Dark Clod	2	0
Smut Coal (good)	3	6

Some of the above measurements (he says), may not be exactly correct, but they are given as near as I at present know them." Any one looking at this section will see the importance of the deposits and their total dissimilarity from the younger Coal-measures.

ALBRIGHTON, WOLVERHAMPTON,
Feb. 5th, 1873.

DANIEL JONES, F.G.S.

CYCLAS CLAY.

SIR,—In describing the Post-glacial deposits of West Lancashire, Mr. C. E. De Rance repeats in your last Number the statement that the peat of the lower plain or that below the 25 feet contour line rests on "Cyclas and Scrobicularia Clays." As the whole of the deposit—which is of considerable thickness—had been previously described by him as "Cyclas Clay," I am at a loss to know whether the Scrobicularia Clay alluded to is that intercalated in the peats; or whether he has changed his views on the subject, and considers the deposit to be of a mixed fresh-water and marine character. If he has changed his views, it is due to the public that such should be stated, otherwise they may be misled by his previous papers and by the geological sheets of the district, in which the peat of the lower plain is stated to rest on "Cyclas Clay."

Having searched in vain for Mr. De Rance's "Cyclas Clay" ever since I read his interesting paper in the Journal of the Geological Society (1870, p. 665), I consider myself entitled to speak on the subject. For the details of my investigations I must refer those interested to my paper on "The Post-glacial Geology of the Mersey Estuary" in the GEOLOGICAL MAGAZINE of March, 1872, and to the more detailed description, with map and sections, in the Transactions of the Liverpool Geological Society, 1872. In these communications I have proved by the most ample evidence that the whole of the beds in question are of *marine origin*, and have named them the "Formby and Leasowe marine-beds." Until the facts brought forward by me are disproved, it is vain to go on repeating that the peat is underlain by "Cyclas Clay"; and unless this is done, the mis-description in the Geological Map 90° S.E. ought to be at once corrected.

T. MELLARD READE, C.E., F.G.S.

HEATH HOUSE, BLUNDELLSANDS, LIVERPOOL,
6th February, 1873.

CALCEOLA SANDALINA.

SIR,—Respecting the paper of Rev. [illegible] "Notes on *Calceola sandalina*, Lam.," in the February Number of the GEOLOGICAL MAGAZINE, I must call the attention of English geologists to another paper on the same subject, published [illegible], in the "Zeitschrift der Deutschen geologischen Gesellschaft," pp. [illegible], pl. [illegible] and [illegible].

The author, Dr. Kunth, of the University of Berlin, one of our most promising and cleverest geologists, and one of the most deplored victims of the French ride-bullets at the battle of Saarbrücken, 1870, has explained in this paper, in a most satisfactory and complete way, as he used to do in all his papers, the structure, the law of increase of *Calceola sandalina*, and its relation to the other Palæozoic Zoantharia rugosa, and to the recent Corals. See also his paper in the same journal, [illegible], pp. 24–43, pl. [illegible]. This, I hope, will keep the priority to the more complete paper of Dr. Kunth.

UNIVERSITY OF MARBURG, GERMANY.
February [illegible]

A. VON KOENEN.

THE AGE OF THE NORTH OF ENGLAND ICE-SHEET.

SIR,—In replying to Mr. Fisher's letter in your last Number, I am happy to say that I had read his valuable papers, and with much interest; but when using the word "trail" I meant it in its ordinary English sense, and not in that special sense to which he would appropriate it. Nor was I referring to his papers when using the word; for I am not aware that he has called attention to that particular phenomenon, the overturning of basset edges, which I was describing when I employed it. So far as I understand from Mr. Fisher's writings, his "trail" is almost a synonym for till, except that he applies it to the till of what he considers a particular epoch.

Mr. Fisher objects to my speaking of "the Glacial Period": I must be content to shield myself behind eminent geologists, who have done, and still do, the same when speaking of general glacial phenomena or of deposits of indeterminate glacial age.

As to the age of the Ice-sheet of the Irish-Sea basin, I am unable to say whether or no it is synchronous with Mr. Fisher's Trail Period. I have already tried to show that it was subsequent to the occupation of West Yorkshire, Lancashire, etc., by the Mammoth, tichorine Rhinoceros, cave-hyæna, and cave-bear, and that these animals probably never returned to that area again.

It is quite possible that here too (as pointed out by Mr. James Geikie for Scotland) palæolithic man may have lived with these animals whose remains are associated with his works in the South of England. For certainly the complete absence of palæolithic implements and fauna over co-extensive areas which have been overridden by the Ice-sheet is a significant coincidence.

To whatever scene or act of the glacial drama we may assign the great ice-sheet, one thing is certain, that it was succeeded by a period of depression, well marked by marine sands and gravels up to 600 or 700 feet in North Lancashire, and supposed by some to be shown by more doubtful deposits at greater heights.

This comparatively mild period gave place to a sea crowded with floating ice, wherein the Upper Boulder-clay was deposited on the Gravels, and perhaps on the highest islands glaciers were forming and sending off little icebergs into the channels of an archipelago. But the ice of this cold period never attained sufficient strength to plough out of the arms of the sea the sand and gravel of the preceding mild period. It could not therefore have been the agent which swept the remains of the older mammals off the face of the district, but probably belonged to the latest cold period in Britain, and I can only say that that of the Ice-sheet is the earliest of which we have any traces left in Lancashire and West Yorkshire.

UNIVERSITIES' CLUB, JERMYN ST., S.W. R. H. TIDDEMAN.

ON SUBSIDENCE AS THE EFFECT OF ACCUMULATION.

SIR,—Will you permit me to make a few remarks upon the critique on "Valleys, Deltas, Bays, and Estuaries,"[1] in the last Number of the GEOLOGICAL MAGAZINE?

The reviewer charges me with attributing to such small accumulations, as those of "a delta, a shingle-beach, or the ice and droppings of a glacier," the power of weighing down gradually the crust of the earth. Such an opinion would, indeed, be "pushing a theory too far," even to absurdity.

The accumulation in a delta represents a comparatively infinitesimal portion of the débris, derived from the disintegration of the material, formerly occupying the space that constitutes the area of a valley, and which has been removed during the process of its formation, having been carried down by the river and deposited near its mouth and *in the neighbouring sea.*

It is considered that during the Glacial Period, there were not simply Glaciers in Britain, but that the country was enveloped in a mantle of snow and ice, similar to what now exists in Greenland; and it has been estimated that in some parts it must have attained a thickness of at least 2000 feet. Supposing the weight of this mass was the same as that of a similar depth of water, it would indicate an increase of pressure on the surface of the land amounting to 937 lbs., or about *eight hundredweight and a half* to the square inch.

Dr. Robert Brown (Quart. Journ. Geol. Soc., xxvi., p. 681), states that he can find no appreciable difference between the deposit of the mud, with which in Greenland the sub-glacial streams are loaded, and that of the clay of the Boulder-clay, and it was to such a source I attributed its formation. Though its thickness in this neighbourhood is in places considerable, even after much denudation, as its deposition occurred close to a land-margin, it will probably at all times have been moderate compared with that which lies beneath the waters of the Bay of Liverpool. "The droppings of glaciers," *i.e.* the scratched and other boulders and pebbles contained in the

[1] An abstract of this Essay was given in the GEOLOGICAL MAGAZINE, Vol. IX. p. 119.

Boulder-clay, through a [illegible] fissure in the formation, have [illegible] a small amount [illegible] and therefore can by its weight have had [illegible] a slight effect in causing subsidence.

As depression of the land not only in recent but also in Palæozoic formations has necessarily occurred simultaneously with that of large accumulations, it therefore appears to me that we are at all events justified if not compelled to consider that the one is dependent upon the other, unless indeed it may be hereafter proved that there has been some other influence acting during such periods and in the same localities having as great a power in inducing it as the pressure of such immense masses in its [illegible].

There may be greater grounds for doubt in attributing that subsidence which has resulted in forming the harbours of Portsmouth and others on the Southern coast to the weight not of a shingle beach, but of large accumulations in the English Channel arising from the rapid waste of the cliffs by marine denudation, and which have been carried by tidal and other currents towards the east, because it is a solitary example, and there are no means of estimating what may be their thickness at a distance of some miles from the land where the deposit is probably greatest; but at Spithead, where it must be comparatively thin, it was pierced during the erection of the forts to the depth of 54 feet without penetrating through it.

CHARLES RICKETTS.

22, Argyle Street, Birkenhead, Feb. [illegible]

MISCELLANEOUS.

NEWBURY DISTRICT FIELD-CLUB.[1]

In the first place the details of the beds shown in the pits were noticed, beginning from the top. The highest part of the section is in brown London Clay, with its marked "basement-bed," here consisting of about ten feet of brown loam, or sandy clay, with casts of shells, and with a layer of flint pebbles at the bottom. Below the London Clay there is a good exposure of the formation known as the "Woolwich and Reading Beds," here about 50 feet thick, and divisible into three parts—the uppermost consisting almost wholly of variously coloured mottled plastic clays, often used for the manufacture of common pottery ware, and about 25 feet thick; the middle of light-coloured sands, more than 12 feet thick, and with a thin bed of pale bluish-grey clay, which, on being split along the lines of lamination, often discloses impressions of leaves; and the lowermost, known as the "bottom-bed," about 12 feet thick, and consisting of dark bluish-grey laminated clay, with green sand, flint pebbles, sharks' teeth, oyster shells, and rare impressions of smaller shells, besides the remains of microscopic animals, found by Professor ones. At the base there are unworn angular flints, with their surfaces coloured reen, lying on the lowest formation of the neighbourhood, the Upper Chalk, or hite chalk with flints, the top of which is in this section riddled with small tubular ollows, that have been filled in with the green sand of the overlying bed.

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[1] Remarks on the Section at Shaw Clay Pit, and its relation to the Geology of the District. A field-lecture given by W. Whitaker, B.A., F.G.S., of the Geological Survey.

Attention was then drawn to the particular beds that should be searched for fossils, amely, the basement-bed of the London Clay, the "leaf-bed," and the bottom-bed f the Woolwich and Reading Series, and the chalk; and the speaker expressed a hope at local observers would constantly visit the section, in order to preserve whatever ecimens might be found, and to record the bed from which each had been got.

The geological conditions of the three formations shown in the pits were touched a; the lowest, the Chalk, giving evidence of having been deposited in a very deep a; the next above, the Woolwich and Reading Beds, being on the contrary of allow water origin, whether in the state of almost unfossiliferous mottled clays and nds, as in this neighbourhood, or that of the fluviatile deposits that replace these ottled clays to the westward (Kent); and the London Clay again pointing to a eper and a rather warmer sea, although the abundant plant remains that sometimes ccur in it show that land must have existed at no very great distance during its position at such places.

In the third place, the relation of the section to the general geological structure of e district (which forms part of the "London Basin") was described, and by means f sections (kindly brought by Professor Jones) the position of the Bagshot Beds, hich overlie the London Clay at no great distance, was shown, as also the uprise of pper Greensand from beneath the Chalk at Kingsclere. The other points noticed ere: (*a*) the uniformity of the Chalk over a large area; (*b*) the varying nature of the ext series of beds; (*c*) the uniformity of the London Clay, and its westerly thinning way from 400 feet near London to less than 100 feet at Newbury, and to nearly othing in an outlier near Marlborough, where it is represented only by the layer of ebbles at the bottom; (*d*) the occurrence of beds of gravel, of late geological age, ver the various formations, firstly as cappings to many of the hills, and secondly ewer) as deposits along the valleys, like those in which "flint implements" that ust have been made by the hand of man have been found elsewhere; and (*e*) the st geological formation of the neighbourhood, the peat and shell-marl of the Ken-et. The formation of "pipes" or hollows in the chalk, by the dissolving away of at rock by carbonated water, was also alluded to.

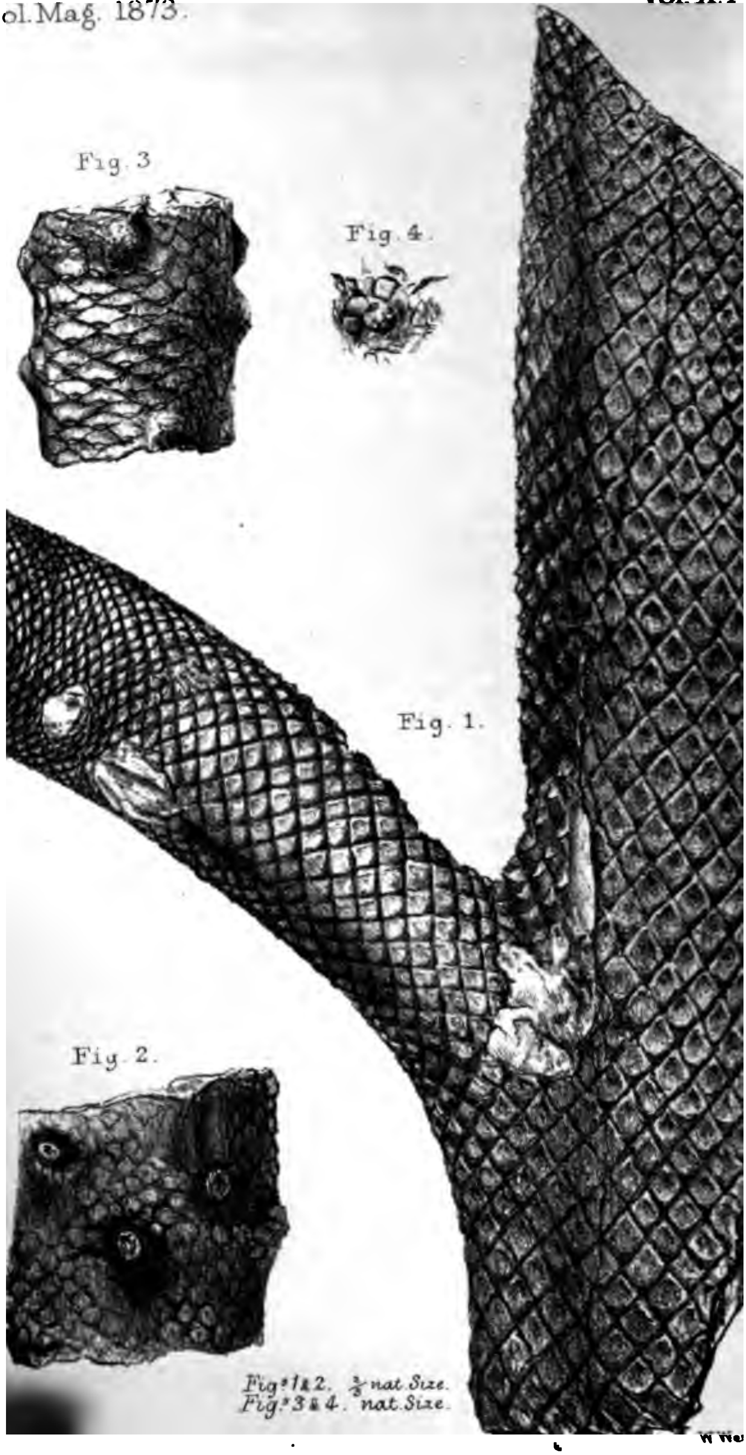
Lastly, it was pointed out that the present surface of the ground was owing to enudation, or the wearing away of the various beds, the present outcrops of which ere by no means their original boundaries, for they must once have spread far be-ond where they are now to be seen. Evidence of this is given in the case of the ondon Clay and the Reading Beds, by the occurrence of "outliers," or detached asses, miles away from the main mass, with which they must once have been onnected. In the case of the Chalk, the former extension is shown by the occur-ence of masses of flints, comparatively unworn, at great distances from the nearest halk now left. The former continuity of the formations in the London Basin, with e same formations in the analogous district known as the "Hampshire Basin," as shown by means of the diagrams, as well as the disturbances that had thrown e two areas into their present form and brought the various beds within reach of e denuding forces. The agents of this denudation were firstly the sea, which had laned down the beds to a more or less level surface, and secondly, the actions now oing on over the surface of the land by the means of atmospheric disintegration, or eathering, of rain and of rivers; actions which, from being for the most part of a radual character and every day before us, are liable to have their power much under-ated, though when carefully investigated they are seen to be most powerful, and ble, in the course of long periods of time, to effect very great changes.—From the *ewbury Weekly News*, No. 297, October 10th, 1872.

THE NEW WOODWARDIAN PROFESSOR OF GEOLOGY FOR CAMBRIDGE.

The election of a successor to the late Professor Sedgwick was held on the 20th February, when Mr. Thomas M'Kenny Hughes, M.A., of Trinity College, was chosen by a majority of seven. By a statute of the University, the election must take place within one month from the vacancy being declared. No fewer than nine candidates had issued applications to the electors who were the members of the Electoral Roll, consisting of the Heads of Houses, Professors, University Examiners, and resident members of the Senate. The candidates were as follows: Rev. O. Fisher, F.G.S., Rev. T. G. Bonney, F.G.S., and Messrs. T. M'K. Hughes, F.G.S., and A. H. Green, F.G.S. (Cambridge), Rev. P. B. Brodie, F.G.S., Mr. W. Boyd Dawkins, F.R.S., and Mr. T. H. G. Wyndham, F.G.S. (Oxford), Prof. Morris, F.G.S., and Prof. Martin Duncan, F.R.S. (London). Several of the candidates retired before the election, and the contest was virtually between the Rev. T. G. Bonney, M.A., Fellow of St. John's College, who has resided constantly since taking his degree, and is a noted member of the Alpine Club. Prof. Morris, who acted as Deputy to Professor Sedgwick, received one vote (Prof. Morris had however retired two days before); and the Rev. Osmond Fisher, of Jesus, obtained four votes; but it is only right to state that he retired within the first half-hour of the polling. The hours of polling were between 1 and 2·30 P.M, and it was conducted with much animation, over 200 of the electors recording their votes, those who did not vote being principally non-resident Examiners. At half-past 2 the Vice-Chancellor declared the result of the poll to be as follows: —Hughes 112, Bonney 105, Fisher 4, Morris 1.

He thereupon declared Mr. Hughes duly elected, and that gentleman was formally admitted to the Professorship.

The new Professor is a member of Trinity College, where he graduated as B.A. in 1857, and ten years later proceeded M.A. While an undergraduate he was an associate of the Ray Club, and a constant attendant at Professor Sedgwick's lectures. After taking his Bachelor's degree he was engaged in tuition for two years, and at the commencement of the year 1860 went to Rome in the capacity of Secretary to Her Majesty's Consul, and was left as Acting Consul during the summer of that year, when he took the opportunity of studying the sub-Apennine formations, and made a collection of fossils from them, and also from the more recent deposits of the Valley of the Tiber. In 1861 Sir Roderick Murchison nominated him upon the Geological Survey, upon which he has served. He has been engaged also in various foreign tours with Sir Charles Lyell. He has mapped for the Geological Survey parts of the counties of Kent, Hertford, York, and Westmoreland, and has published various papers on geology, printed among the Geological Society's "Proceedings," and in the Geological Magazine. He is also a contributor to "Nature" and other scientific publications.—(Partly taken from *The Times, 21st Feb.*, 1872.)



Halonia, Lindley & Hutton.

THE
GEOLOGICAL MAGAZINE.

No. CVI.—APRIL, 1873.

ORIGINAL ARTICLES.

I.—ON *HALONIA* OF LINDLEY AND HUTTON AND *CYCLOCLADIA* OF GOLDENBERG.

By WILLIAM CARRUTHERS, F.R.S.,
Of the British Museum.

(PLATE VII.)

THE genus *Halonia* was established in the Fossil Flora (vol. ii., p. 13) by Lindley and Hutton for those fossils in which, to the surface of *Lepidodendron*, is added the mode of branching of certain *Coniferæ*, and which were therefore inferred to be of a nature analogous to the latter. It was assumed that *Lepidodendron*, being an extinct form of *Lycopodiaceæ*, must be limited to the fossils in which the branching was dichotomous, since no other kind of branching is met with in recent *Lycopodiaceæ*. But when we look at such plants as *Lycopodium cernuum* and *L. densum*, we find branching precisely similar to that in *Halonia gracilis*, L. and H.; and whether these were produced or not by the division of a terminal bud, it is certain that in their developed condition they are arranged in an alternate manner round a common elongated axis—a plan of branching characteristic, as the authors of the Fossil Flora supposed, of *Coniferæ*.

Whether this plant be Lycopodiaceous or Coniferous however, the genus was accepted, and has been retained by subsequent systematists. Lindley and Hutton figured a second species, to which they gave the name *H. regularis* (l.c. plate 228); and a third fossil they referred with doubt to the same genus, *H. ? tortuosa* (l.c. plate 85). In the description of the latter fossil many conjectures are thrown out, but no accepted interpretation is adopted.

Brongniart, in the unfortunately incomplete second volume of his "Histoire des Végétaux Fossiles," (1837) figures (plate xxviii., fig. 2) a characteristic specimen, on a portion of which the film of coal remains, with indications of the leaf-impressions. The letter-press to this plate was never published. The genus is shortly described by Brongniart in his "Tableau," (1847), and the tubercles which distinguish it are described as being covered uniformly with the common bark and the leaves which spring from it, and are considered by him to be like what would be produced by roots which had not passed through the bark.

Mr. Dawes, in a short paper communicated to the Geological Society in 1848, described the internal structure of Halonia. He rightly concludes that it is not a Conifer, but a vascular Cryptogam, and that its nearest affinity is with *Lepidodendron* (Quart. Journ. Geol. Soc. vol. iv. p. 293). He further suggests that its tortuous root-like appearance may indicate a relationship to *Lepidodendron*. This opinion he communicated to Dr. Hooker apparently in more decided terms than he employs in his published paper; and Dr. Hooker, in his memoir on the "Vegetation of the Carboniferous Period," adopts, but with great caution, this view of the nature of these fossils (p. 422). I cannot here refrain from expressing my regret that Fossil Botany owes so small a debt to Mr. Dawes. The few short papers which he has published exhibit a fidelity of observation and description, and a just appreciation and interpretation of the structures observed, which are too rare in many papers on this subject. Besides the paper which I have quoted, I would further refer to his valuable memoir on *Calamites*, which it is to be regretted has never been printed except in abstract.

Geinitz, in his "Steinkohlenformation in Sachsen" (1855), referred Lindley and Hutton's *Bothrodendron punctatum* (Fossil Flora, plates 80–81) to *Halonia*, overlooking the difference between the large sunken scars in the one and the smaller tubercular elevations in the other. One of his figures is of great importance, but to this I shall again return. He proposed a second species, *H. irregularis*, (tab. iv. fig. 5); but the fragment on which it is based appears to me to be a piece of one of the segments of the large Coal-measure Crustacean to which Jordan gave the name of *Arthropleura armata*.[1] I have the authority of my colleague, Mr. H. Woodward, whose labours are well known in this division of the Animal Kingdom, for saying that he agrees with me in this opinion.

Goldenberg, in the same year, published the first part of his "Flora Saræpontana Fossilis," which contained a rude yet instructive drawing of *Halonia* (pl. iii. fig. 12). In his description he refers to the small scars as produced by the leaves, and the larger scars as belonging to other organs, the nature of which he does not specify. The leaf scars were rhomboidal, and in all points agreed with those of *Lepidodendron*, so that he thought it probable that the specimens of *Halonia* were no more than branches of known species of *Lepidodendron*. His figure shows a bifurcating specimen, with the portion of the stem below the branch exhibiting only leaf scars, and the tubercles occurring irregularly on the branches. These tubercles he describes as having a continuous covering of bark, which is marked with leaf scars, and he consequently thinks them due to aborted branches that have not penetrated the bark. This author gives on the same plate a figure of a large stem of *Lepidophloios laricinum*, Sternb., which I believe belongs to the same plant, as does also the specimen figured under the name *Ulodendron flexuosum*, Goldenb. (pl. ii. fig. 10), which shows the rhomboid leaf scars and a double series of conical protuberances, not depressions as in *Ulodendron*. It is further, I think, probable that the leaves (pl. iii. fig. 13), to which the name *Lepidophloios lepidophyllifolium*, Goldenb., is given, are the foliage of the same plant. There can be no doubt as to the fossil on which he founded his genus *Cycloсladia*[1] being an imperfectly preserved *Halonia*. As Goldenberg did not observe any scar at the apex of the tubercles in his specimen of *Halonia*, this rounded scar, which is very obvious in the fragment called by him *Cyclocladia*, is made the principal distinctive character of the supposed new genus.

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[1] See Memoir on Ulodendron, Monthly Microscopical Journal, March, 1870.

[2] See Geol. Mag., March, 1873, p. 107.

Eichwald has figured, in his "Lethæa Rossica," (1860), a remarkably fine specimen of a bifurcating branch of *Halonia regularis*, Lindl. and Hutt., showing on the amorphous cast which fills the cavity the two sets of scars, and in the mould in the rock exhibiting in a very perfect condition the rhomboid marking of the bases of the leaves. The larger tubercles he figures and describes (vol. i., p. 149) as being composed of six to eight smaller ones, arranged together in a radiating manner, and having an open pore in the centre, through which passed the vascular bundle, to the leaves which Eichwald supposed were borne only on the large tubercles. The smaller tubercles, which are symmetrically arranged globular swellings on the internal cast, were not noticed by Eichwald to have any indications of the vascular bundle which passed through them. The rhomboidal scars so well marked on the mould in the rock he considers to have supported scales which densely covered the whole surface of the stem. In placing the genus in the *Lepidodendreæ*, he distinguishes it from *Lepidodendron* by its having the leaves placed upon large tubercles.

In a memoir on the Coal-plants of Westphalia, published in the eighteenth volume of Dunker's "Palæontographica," (1868), Von Roehl supposes that the tubercles may have supported fruits; and this view is also adopted by Schimper as the interpretation of the tubercles, if they are perforated by a vascular bundle, as Eichwald described (Traité de Paléontologie Végétale, vol. ii., p. 53. 1870).

Omitting the works of the systematists who have added nothing to our knowledge of these plants, we come to a valuable paper by Feistmantel on the Coal-plants of Kralup (1871), in which he investigates the nature of *Halonia*, and gives three plates of casts of specimens. He points out the importance of the vascular scar in the centre of the tubercle, and considers it to indicate probably an articulating surface. But the great importance of his paper is the determination that the leaf scars of *Halonia regularis* were the same as those of *Lepidodendron laricinum*, Sternb., and he therefore concludes that these two plants stand to each other in the closest relationship, if they be not indeed one and the same plant (p. 30).

The latest memoir on this subject is that by Mr. Binney, published by the Palæontographical Society (1872). This is chiefly devoted to the description of transverse sections of specimens exhibiting structure. The drawing and description of Mr. Dawes are confirmed by the beautiful illustrations which accompany this paper. Notwithstanding the accumulation of evidence as to the foliar appendages of *Halonia*, Mr. Binney not only completely adopts Mr. Dawes' suggestion as to the root-nature of this fossil, but he comes to the conclusion that *Halonia regularis* is the root of *Lepidodendron Harcourtii*.

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[1] Goldenberg overlooked Lindley and Hutton's earlier use of this name for a fragmentary fossil, which I have shown to be the part of a Calamite stem. See Woodward's "British Fossil Crustacea of the Order Merostomata," part iv., p. 168, Pal. Soc. vol. xxvi. 1872.

Scarcely any two authors have hitherto agreed as to the interpretation of these fossils. Lindley and Hutton considered them to be Coniferous. They have since been invariably placed among the Cryptogams. Dawes and Hooker supposed they might be Lepidodendroid roots, while Binney maintains they are roots of *Lepidodendron Harcourtii*. Eichwald thinks the stems were closely covered with scales, and that the true leaves were borne on the tubercles, while Brongniart considers that the smaller scars were true leaves, and the tubercles rudimentary roots which have not yet penetrated the bark; Goldenberg that they were aborted branches, and Von Roehl and Schimper that they were the points of attachment of the fruits. And lastly Feistmantel is almost certain that *Halonia* has no existence as a genus, and should be incorporated in *Lepidodendron*.

To appreciate the meaning of the fossils included under the name *Halonia*, one must first realize the internal structure of the stem, and the progress of decay and fossilization in the dead plant. The observations of Mr. Dawes, in the paper referred to,[1] establish that the organization of the stem agrees with that of *Lepidodendron*, and consequently consists of an axis composed externally at least of scalariform tissue, surrounded by a considerable thickness of delicate parenchyma, which gradually alters outwards into the regularly arranged and thick-walled prosenchyma of the bark. On the death of the plant the delicate parenchyma, forming the inner portion of the cortical tissues, first decayed. The axis enveloped in this soft mass followed, and last of all the more enduring external bark. The more common specimens of *Halonia* are amorphous casts of the interior of the cortical layer, which exhibit on their surface the elevated tubercles, as well as the small punctiform scars of the leaf bundles. Frequently these latter scars are placed at the apex of a little tubercle; this has been produced by the substance of the cast penetrating the small passage in the outer bark through which the vascular bundle passed. The parenchyma which surrounded and accompanied the bundle having decayed had left an empty cavity which was easily filled from the interior. The *Knorria* condition of normal Lepidodendroid branches and stems is, as I have elsewhere explained,[2] precisely similar to this state of *Halonia*. The specimen with the remarkably regular tubercles figured by Lindley and Hutton ("Fossil Flora," pl. 228) as *H. regularis* is in this condition, as well as Binney's specimen of the same (Palæontographical Society, 1872, pl. xviii.), and that figured on the accompanying Plate at Fig. 2.

Where the specimen was buried in shale, the bark is generally converted into coal, and exhibits the appearance of the specimen drawn in Fig. 3 of the Plate, where the leaf bases are seen on the surface. But when the specimen has been buried in a sandstone, all trace of the fibre of vegetable substance which once existed has been removed, by the slow combustion that has gone on through this porous rock, and which was impossible in the impermeable plastic material of the shale. In this case we find the cast of the interior as in the first condition described, but lying loose in the mould, and the peculiarities of the exterior exhibited on the mould. Sometimes these exterior markings are the counterparts of the imbricated leaf bases shown on the fragment, Fig. 3 of the Plate. This is the condition of the specimens on which Feistmantel's important observations were based, and which are figured by him. More frequently, however, the markings in the mould are rhomboid, as in the bifurcating specimen figured by Eichwald ("Lethæa Rossica," pl. xi.), and reproduced by Schimper (Traité Paléont. Vég., pl. lxvi.), and of the principal figure in our Plate.

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[1] Prepared sections of *Halonia* in the British Museum confirm the observations of Mr. Dawes.

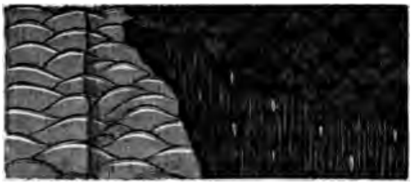
[2] Journal of Botany, vol. vii. (1869), p. 153, plate 93.

To understand the meaning of these two different kinds of external impressions, we must recall the aspect of the surface of *Lepidophloios*, which has been shown to be that of *Halonia*. This generic group was separated by Sternberg from *Lepidodendron*, because of the long persistent bases of the leaves which clothed the stem after the leaf had fallen off. The difference between the two genera is the same as what is found among the stems of some genera in recent *Cycadeæ*. In *Cycas* the leaves separate at the surface of the stem, while in *Encephalartos* the articulation is at some distance from the stem, which is thus permanently clothed with the bases of the leaves. The fall of the leaf is owing to the formation of a transverse layer of cells, which cuts off the petiole by a regular septum, leaving a clear scar of a uniform character in each species. In stems of *Encephalartos*, which are dead and completely desiccated, the persistent leaf bases may be easily broken away at the place of their attachment to the stem. The scar thus produced is very different from that shown on the outer articulating surface; it is a rhomb with the margins closely applied to the surrounding scars, and the surface of the scar itself is without any markings except those depending on the accidents of the fracture.

In *Lepidodendron* the leaf scar is employed to separate the species, and it appears to supply characters which are constant, and consequently of real value, as one would expect from the analogy of recent plants; but it is obviously necessary to secure the true cicatrix in order to determine these characters. A large number of false species of *Lepidodendron* have been established, chiefly upon slight differences in the form of the leaf base, without regard to whether the true surface of the scar is being examined or not. Take, for example, the fossils placed in the genus *Bergeria*, which Presl established to receive Lepidodendroid stems with contiguous rhomboidal leaf scars, perforated at the apex. Unger and others retain this genus, but Schimper places the species at the end of *Lepidodendron*, as "incertæ sedis." None of these fossils with which I am acquainted exhibit any well-marked cicatrix, but are like the scars on the principal stem of Figure 1 of our Plate. The mark of the vascular bundle is only occasionally present. I have no doubt that these represent the stem scars of Lepidodendroid plants which had persistent leaf bases, and consequently that the species of *Bergeria* must, like so many other Palaeozoic species, be considered as provisional, and to be set aside as soon as they can be referred to their true places. The specimens will, I hope, make this obvious.

The most perfect specimen of *Halonia*, as regards its external aspect, is that of which a fragment is represented at Fig. 3 of Pl. VII. This specimen I obtained in situ at Ebbw Vale, when I was examining the fossils of that district under the guidance of my friend W. Adams, Esq., F.G.S., of Cardiff. The outer surfaces of the persistent imbricated bases of the leaves are well shown. On leaving the stem the leaf took a downward direction, so that at first sight a false impression is obtained of the distal end of the branch. It is properly drawn on the plate, with its proximal end downwards. The cicatrix is very small compared with the exposed portion of the leaf base, and is seen to occupy only the lower angle. That the large tubercles were covered with leaves has been over and over again asserted, and is well shown in this specimen. One of the tubercles is represented at Fig. 4 on the Plate. The upper leaves have been removed, but a nearly complete circle is seen surrounding the cone, and these have a downward direction as on the main branch. The tubercles when well preserved show a perforation in the apex, through which a large vascular bundle has passed. The arrangement of the leaf bases and the form of the leaf scars on this specimen agree exactly with *Lepidophloios laricinus*, and consequently confirm the conclusions of Feistmantel.

I am indebted for the fine specimen represented in Pl. VII. Fig. 1, to Sir Ph. de M. Grey Egerton, Bart., of whose extensive collection it formed a part. It is now, by his liberality, placed in the British Museum. The drawing represents a cast taken from the mould, and exhibits what was the external surface of the plant when it was inclosed in the sandstone rock which forms the matrix. This specimen confirms the observation of Goldenberg, that a *Halonia* branch may grow out of a *Lepidodendron*, for here we have the stem of an undoubted *Bergeria* giving off an equally well-marked *Halonia*. But the rhomboid scars, as we have already observed, want the true marks of a cicatrix, like that seen in good species of *Lepidodendron*. They are obviously the scars produced by the separation of the persistent leaf bases at the surface of the stem. I had arrived at this conclusion after a careful examination of a large series of specimens, and of all the published drawings to which I could refer, and I was specially delighted when I found that Geinitz had figured a specimen which confirmed my conclusion, though he had not observed its importance. The accompanying woodcut is a facsimile of a portion of his figure of *Halonia punctata*, Gein., from plate iii., fig. 16, of his "Steinkohl. in Sachs." The cortex and leaf bases are converted into coal, as in the specimen represented in Fig. 3, Plate VII.; but the amorphous cast of the axis is removed. The rocky matrix exhibits the form of the leaves of *Lepidophloios*, the middle layer shows the rhomboidal scars of *Bergeria*, and the upper or inner surface the oval openings in the inner bark, through which the vascular bundles passed to the leaves. This one specimen combines in itself all the forms under which *Halonia* is found.



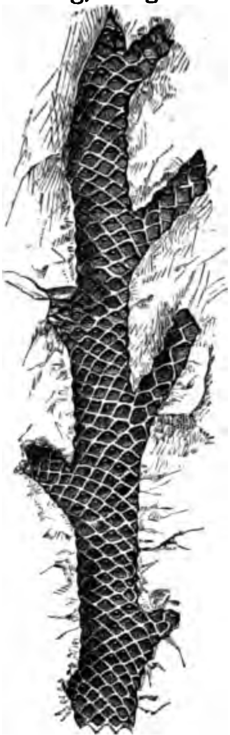
Halonia punctata, Geinitz, Steinkohl. in Sachs., pl. iii., fig. 16.

The first result of this determination is to show that leaf scars which are not those of the articulating surface are worthless for basing diagnoses upon. Some forms of *Bergeria* are forms of *Lepidophloios*; others belong, as I have observed, to species of *Lepidodendron*, in which the leaf cushions are somewhat tumid. *Bergeria* then, and all species or genera based on scars which do not show the articulating surface, must be eliminated from our lists. And with *Bergeria* must go *Halonia* as a separate genus, seeing that it is only a condition of *Lepidophloios*, and it may be of other Lepidodendroid plants. *Cyclocladia*, of Goldenberg, being founded in error on an imperfect specimen of *Halonia*, disappears also of course with it.

The group of Lepidodendroid stems which have large round or oval depressed scars on their stems, and which form the genus *Ulodendron*, have the rhomboidal leaf scars of *Bergeria*. I have elsewhere given my reasons for considering these large impressions to have been produced by aerial roots. It seems to me not improbable that *Ulodendron* may be the main stem of plants of which *Lepidophloios* and *Halonia* were the younger portions.

I have no doubt that *Halonia* was a fruit-bearing branch. Lepidodendroid plants had their fruits in the form of cones,—that is to say, of modified branches. The falling of the ripe cone would leave such a scar as terminates all the tubercles. The arrangement of the tubercles is very variable. In some specimens they are arranged symmetrically, but the same branch sometimes shows considerable differences. Such a specimen exists in the Museum of the Bradford Philosophical Society; it has the tubercles somewhat crowded at the one end, and few and distant at the other.

A fine specimen from the Dudley Coal-measures, now in the collection of the British Museum, shows the nature of the



Halonia gracilis, Lindl. and Hutt.

branches of Lindley and Hutton's original species of *Halonia*. Mr. Dawes considered the alternate branches to be merely the impressions of the tubercles which characterize the other species of *Halonia*. The specimen I here figure shows that these lateral branches attained to some length. In none of them is the natural termination shown. The size and form of the scars at the broken ends indicate that the branches were prolonged.

EXPLANATION OF PLATE VII.

FIG. 1. Stem of *Bergeria* giving off a branch of *Halonia regularis*, Lindl. and Hutt. Drawn, two-thirds the natural size, from a specimen presented by Sir Ph. de M. Grey Egerton, Bart., to the British Museum.

FIG. 2. Internal cast of *Halonia regularis*, in the condition to which Goldenberg gave the name *Cyclocladia*. Two-thirds nat. size. From a specimen in the Brit. Mus.

FIG. 3. *Halonia regularis*, with the leaf bases and scars of *Lepidophloios*. Natural size. From a specimen in the British Museum.

FIG. 4. One of the tubercles from Fig. 3, showing the persistent bases of the leaves surrounding the tubercle.

II.—NOTE ON *PTERASPIS KNERI*.

By MAGISTER FR. SCHMIDT,
Of the Imperial Academy of Sciences, St. Petersburg.

IN the course of last summer I visited the banks of the Dniester, in Podolia and Galizia, where I was fortunate in collecting, near Zalesczyki, a number of shields belonging to *Pteraspis* (*Scaphaspis*) *Kneri*, Lank.

As I observed that the shields of *Pteraspis* and *Scaphaspis* always occurred together, I was led to the conclusion that these shields might, in all probability, belong to one and the same animal, *Scaphaspis* representing the ventral shield of *Pteraspis*[1] in the same manner as in the genus *Coccosteus*, which possesses both a dorsal and a ventral shield.

Diagrams of the Shields of the several Genera of HETEROSTRACOUS CEPHALASPIDÆ (after Lankester).

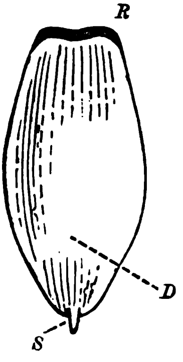


Fig. 1. *Scaphaspis*.

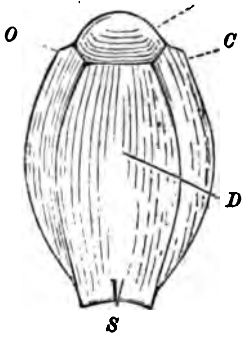


Fig. 2. *Cyathaspis*.

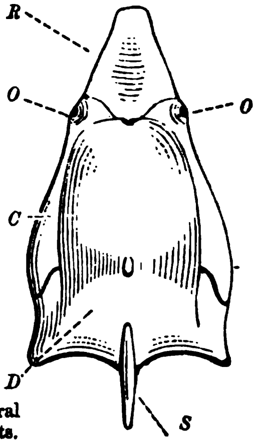


Fig. 3. *Pteraspis*.

R = Rostrum, or Rostral region. *C* = Cornua. *D* = Central disc, or Discal region. *S* = Posterior spine. *O* = Orbits.

[In order to render Prof. Schmidt's views more clear to the readers of the GEO-

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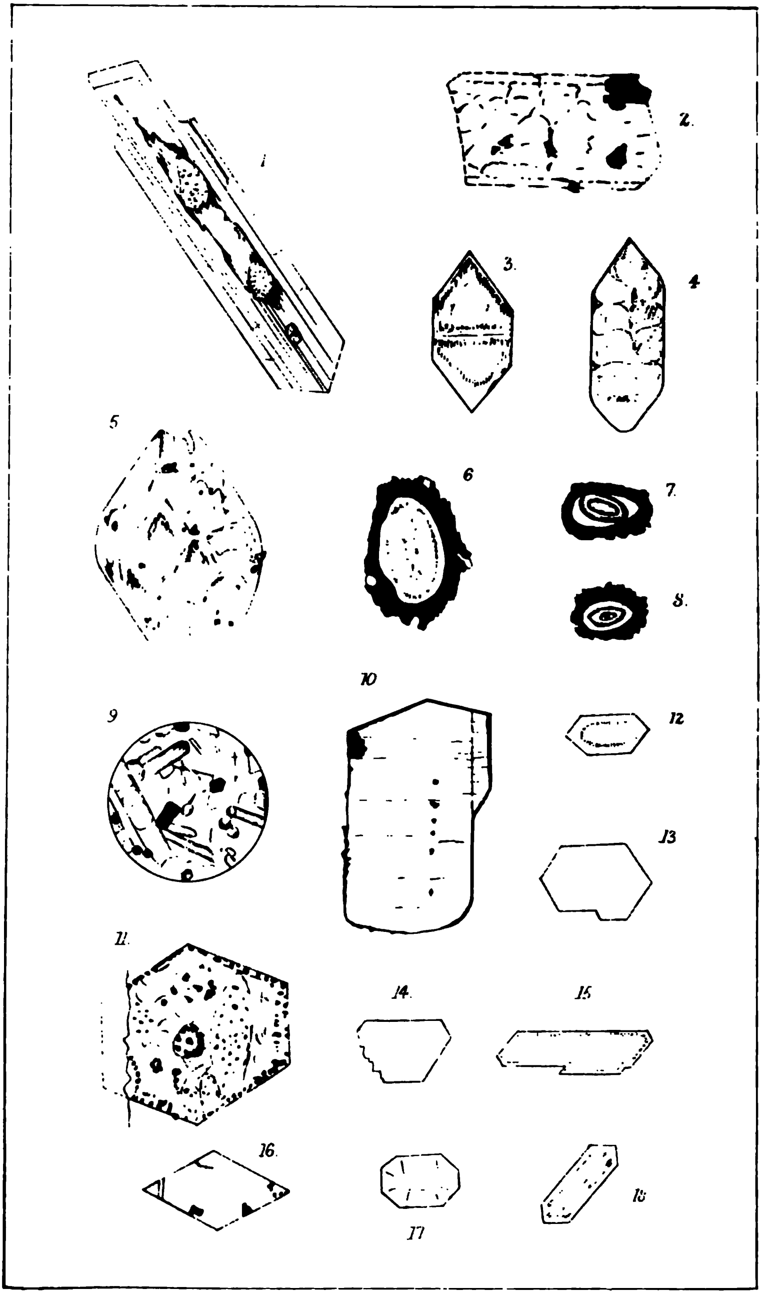
[1] See the "Placodermen des Devonischen Systems," by Pander, p. 4.



G.L. Griesbach
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[redacted]scopic Crystals Observed by Prof. Hull in the
Trap-rocks of Limerick.

LOGICAL MAGAZINE, we have reproduced the above diagram woodcuts from Mr. E. Ray Lankester's excellent monograph on "The Fishes of the Old Red Sandstones," Pal. Soc. Mon., vol. xxi., 1868, part i. p. 15.—EDIT. GEOL. MAG.]

This opinion has been greatly supported by the late Dr. A. Künth (Zeitschrift d. Deutschen Geolg. Gesellsch., 1872, p. 1), who found *Pteraspis* (or *Cyathaspis*) in one piece, together with *Scaphaspis*.[1]

But I cannot agree with Künth, who thinks that *Pteraspis* belongs to the CRUSTACEA! nor with Eichwald, who supports the old notion of Kner, that *Scaphaspis* is the bone of a Cephalopod.

Pteraspis Kneri occurs in the uppermost Silurian beds of Galizia, associated with *Leperditia, Beyrichia, Tentaculites ornatus* and *tenuis, Orthonota rotundata, Pterinea retroflexa,* etc. It is also very abundant in the Red Marls and Sandstones covering the Silurian Limestone. These sandstones represent the lowest stratum of the Old Red Sandstone, and contain, besides *Pt. Kneri,* remains of *Pterygotus* and pieces of ornamented tuberculated shields very much resembling those of *Pterichthys* and *Coccosteus.* I am satisfied that there exists in Galizia an unbroken succession of Animal life from the Uppermost Silurian strata to the Lowest Devonian, just as is the case in the West of England, in Herefordshire. (See Murchison's "Siluria," 1867, p. 243.)

In perusing the valuable Memoir by Mr. Ray Lankester (in vol. xxi., 1868, and vol. xxiii., 1870, published by the Palæontographical Society), I was sorry to observe that a former article of mine on the Russian Cephalaspidians (Ueber *Thyestes verrucosus* ünd *Cephalaspis Schrenkii,* in Verhandlungen der Kaiserlichen Mineralogischen Gesellschaft, St. Petersburg, 1866) had been overlooked by him. In that article I established the new genus *Tremataspis,* which, to some extent, connects by its microscopic structure the genera *Cephalaspis* and *Pteraspis.*

I regret that I have not any separate reprints of that article remaining, or it would have afforded me much pleasure to forward a copy to the author of "The Fishes of the Old Red Sandstone," but doubtless the "Verhandlungen," etc., exists in the Library of the Geological Society of London, to which I beg leave to refer Mr. Ray Lankester.

III.—ON THE MICROSCOPIC STRUCTURE OF THE LIMERICK CARBONIFEROUS TRAP-ROCKS (MELAPHYRES).

By PROFESSOR EDWARD HULL, M.A., F.R.S.

(PLATE VIII.)

[Read before the Royal Geological Society of Ireland, 12 March 1873.]

DR. MACALISTER, in his able Presidential Address, has furnished the Society with a summary of the work done, principally by German petrologists, with the object of determining the mineral constitution and structure of plutonic, metamorphic, volcanic, and other rocks, by the aid of the microscope. Forbes, Sorby, and Allport amongst ourselves have also represented British petrologists in the same field, but perhaps have not been sufficiently forward in giving the results of their labours to the world. As representing the Geological Survey in this country, I may mention that I have been fully alive to the great benefits to be derived from the use of the microscope, and nearly one hundred specimens of sliced rocks have already received a certain amount of scrutiny, and the results have been noted. These results will be from time to time inserted in the Explanatory Memoirs which are published along with the Geological Maps; and the Memoir issued last year (1872) on the Geology of portions of Counties Down and Armagh, near Banbridge,[1] will be found to contain the first of these published series of observations on the microscopic structure of some of the rocks of the district.

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[1] For Mr. Lankester's reply to Dr. Künth's paper (extracted from the *Academy*) see *infrà*, p. 190.

Amongst the rocks which I have had opportunities of microscopically examining, the basalts and dolerites of the North of Ireland and the older melaphyres of County Limerick have received some attention; and I purpose in this paper to institute a comparison between these two classes of rocks, which may be considered as the representative augitic lavas of the Miocene and Carboniferous periods in Ireland.

Authors of Papers on the Limerick Trap-rocks.—The geological structure of the Limerick Carboniferous basin has been described by several writers. Of these may be specially mentioned Mr. Weaver,[2] Dr. Apjohn,[3] Mr. Ainsworth,[4] Sir R. Griffith,[5] and Messrs. Jukes, Kinahan, and Wynne.[6] From the description, often exceedingly full, which these authors have furnished, it is now understood that the trap-rocks of the Limerick Carboniferous basin are themselves of Carboniferous age. As Mr. Kinahan observes, these traps and associated ashes form two great deposits, occupying well-defined geological horizons; the lower coming in a little above the base of the Lower Limestone, immediately over the cherty beds that are taken as the division between the Lower and Upper Limestones; and the upper, a little below the basal shales of the Coal-measures.[7] There seem to have been two principal out-pourings of lava from sub-marine or subaerial vents, accompanied by eruptions of ashes and agglomerates, the materials having been strewed over the adjacent seas; and Mr. Jukes suggests that some of the detached bosses of trap are to be regarded with great probability as the volcanic foci or "necks" of these old Carboniferous craters.[8]

Names and Mineral Characters of the Rocks.—Though these trap-rocks present considerable variations in appearance and texture, they are more or less basic (with one exception), and probably augitic. The terms they have received, however, from various authors are numerous, such as "Greenstone," "Basalt," "Porphyry," "Amygdaloid," "Spilites," "Diorite," and "Melaphyre." Let us hope that the term "Greenstone" will in course of time—and chiefly through the aid of the microscope—fall into oblivion; at present it can only be regarded as a word intended to conceal our ignorance.

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[1] Expl. Memoir to accompany Sheet 48 of the Maps of the Geol. Survey.

[2] "On the Geological Relations of the East Coast of Ireland." Trans. Geol. Soc., Lond., vol. v., by Thomas Weaver, M.R.I.A.

[3] "Observations on the Trap District in the Co. Limerick." Journ. Geol. Soc. Dub., vol. i. p. 24 (1832).

[4] A Further Account of the Limerick Trap-rocks, by William Ainsworth, (1833) with Map.

[5] Geological Map of Ireland, with reference (1839).

[6] Explanations of the Geological Survey Maps, Sheets 143, 144 (1860).

[7] *Ibid.* Sheet 44, p. 24.

[8] *Ibid.* Sheet 143, note p. 10.

Assuming the words "greenstone" and "diorite" to be synonymous, and intended to designate a crystalline rock composed of hornblende and felspar, it is questionable whether such a rock is actually to be found amongst the Limerick trap series, although crystals of hornblende do sometimes occur as accessories.

As stated by the officers of the Geological Survey, "These rocks are of dark and light green, dark and light blue, or reddish colours, the latter being often due to decomposition. Their texture is generally compact, or fine-grained, with crystals of felspar widely dispersed through the mass; other crystals are rare, and some even of those traps, which from their dark colour have been called 'greenstone,' seem almost entirely felspathic. Some of these rocks pass imperceptibly into porphyries and amygdaloids, which have many varieties in the different localities in which they are met with." Mr. Jukes adds in a note, "A detailed chemical investigation into the composition of these varying trap-rocks would be very interesting and instructive. Without it, it is impossible to guess the proportions in which the felspathic are mingled with the augitic or hornblendic minerals; or even to decide on the nature of the felspars themselves."[1]

It is exceedingly interesting to observe that similar rocks occur in great force amongst the Lower Carboniferous beds of Scotland, forming the ranges of hills which bound the Coal-field of the Clyde basin along both its northern and southern borders. They have apparently been erupted from volcanic vents at the same, or nearly the same, period of geologic time as the Limerick traps themselves, while in the "toad-stones," or basaltic amygdaloids of Derbyshire, we recognize the English representatives. Thus it appears that in the regions now occupied by the S.W. of Ireland, the centre of Scotland, and the centre of England, volcanic craters, in all probability submarine, were in active operation, pouring forth over the bed of a highly populous sea sheets of lava, and vomiting forth ashes and agglomerates amongst forests of crinoids and tribes of molluscs and corallines. When, in 1868, I brought over some specimens of these rocks from Scotland, and showed them to Mr. Jukes, he at once recognized their similarity to "the Limerick trap-rocks."

The case here mentioned is an instance of the homogeneous character of igneous rocks of the same age over considerable tracts of country, which seems to me to have important bearings on the question of the internal fluidity of the earth below the solid crust.

Microscopic slices.—Of the twelve sliced specimens which I have examined, taken from various places over the district, all but one belong to that general group of augitic rocks which may be conveniently named "melaphyres," and which are the representatives in Mesozoic and Upper Palæozoic times of the more recent basalts and dolerites. In general structure these Limerick melaphyres consist of a glassy colourless felspathic base, in which are imbedded crystalline grains of augite, magnetite (or titano-ferrite), pseudomorphs of olivine occasionally, with a considerable infusion of chlorite and calcite. Sometimes large crystals of banded felspar occur, as in the specimen from Herbertstown. In all cases, however, the base is a glass, and the augite only occurs in distinct grains, and is by no means abundant at any time. The dark green colouring of the rocks is due to the generally large number of magnetite grains and the abundance of chlorite or epidote. I now proceed to give a brief account of the individual sliced specimens which I have examined:—

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[1] Explanation to Sheet 44, p. 9.

(1). *Specimen from Herbertstown* (Lower Trap-band).—Base a glass with cavities and tubes, passing into crystalline granular triclinic felspar, with light-brown crystalline grains of augite, large crystals of banded felspar, magnetite grains, and chlorite filling in cavities, and in distinct grains.

Augite.—Some of the crystals are very well formed, and inclose magnetite grains. They are of a pale brown colour, much fissured, and are locally numerous.

Felspar crystals.—The large crystals porphyritically imbedded show, with polarized light, the banded structure and the fine lines characteristic of one of the triclinic group.

Chlorite.—The chlorite occurs as filling in the interstices in the base, and between the crystals, but sometimes as distinct grains, with the rounded or oval form resembling grains of olivine. It is not improbable it has replaced this latter mineral. In some places it assumes the vermiform structure which is not uncommon, and it has every appearance of being a "secondary" mineral, infiltrated into the rock after consolidation.

(2). *Specimen from Roxborough* (Lower Trap-band).—This is an exceedingly interesting specimen, containing well-formed crystals of augite, olivine, triclinic felspar, and (which is rare) hornblende, the latter large and well defined; the whole imbedded in a base blackened by magnetite. The substance of the crystals is generally entirely changed, and replaced by a yellowish mineral (epidote or chlorite) and calcite. The base seen with the quarter-inch power (200 diams.) is a colourless or yellowish glass, full of magnetite crystals, and having long slender prisms of triclinic felspar imbedded therein; also nests and pockets of a yellowish-green mineral with radiate-fibrous structure, probably epidote. This mineral—sometimes without structure—frequently replaces the substance of the augite, olivine, and hornblende.

The specimen is remarkable for the large well-formed crystals of hornblende. porphyritically developed. Generally the walls of the crystals are filled in with secondary minerals, such as epidote and calcite; but there is one crystal retaining the original brownish-fissured substance of the hornblende itself. This crystal enabled me to apply the test of dichroism, which Tschermak and Allport have both proposed for the determination of hornblende as against augite. The mineral is more strongly dichroic than any specimen of hornblende I have yet examined, while the forms of the crystals are of themselves sufficiently distinct for identification. But for this specimen, I would have doubted the occurrence of hornblende amongst these rocks.

(3). *Specimen from Bathjordan* (Upper Trap-band).—Base a colourless glass, sometimes tinged green, with multitudes of belonites crossing each other in all directions, and numerous elongated cavities. This felspathic base is darkened by crystalline grains of magnetite, and contains crystals of augite and long prisms of felspar. The crystals of augite and felspar are generally replaced by chlorite (?).

Augite.—The crystalline grains of augite are all more or less replaced by chlorite; but the forms are decisive, and are made very plain by polarized light.

Chlorite (?).—Light greenish mineral, with fibrous structure, filling cavities or interstices; as well as replacing the material of the augite and some of the felspar crystals.

Calcite.—With polarized light, the peculiar smalt-blue and opalescence of calcite is apparent, filling fissures and interstices in the felspathic base.

Cavities.—With the quarter-inch power, magnifying 200 diams., numerous cavities are observable all through the glass base. Some of these appear to be tubes, sometimes truncated obliquely; others are polygonal, or rounded. These are mixed up with numerous "belonites," very similar in appearance to those of pitchstone, and about the same size as those in a specimen from Ascension Island with which I compared them.

(4). *Specimen from Rothjordan* (Upper Trap-band, columnar).—This specimen much resembles the last. The glass base contains belonites, and cavities; and along with well-defined brownish crystals of augite are numerous pseudomorphs after olivine, filled with the chloritic mineral which is so abundant in these rocks.

(5). *Specimen from Ballybrood* (Upper Trap-band).—This is similar to Nos. 3 and 4. The glass base contains belonites and numerous elongated cells. The form of the crystals of augite are remarkably well defined, but the substance of the mineral itself is often replaced by chlorite and calcite. The crystals of magnetite often present well-defined forms, but I could observe none resembling those of olivine.

(6). *Specimen from Ballytrasna—Porphyritic* (Upper Trap-band).—I have two slices of this. The base is a glass with cells and belonites in places, much charged with magnetite grains and crystals. In this are imbedded well-formed augite crystals of a light-brown colour, with imbedded grains of magnetite. One of these (a fragment) is a large hexagonal crystal filled with a colourless and structureless mineral, probably calcite. There are numerous large crystals and groups of banded felspar, with a very fine appearance under polarized light; the augite crystals—showing a fine play of golden bronze, and roseate colours on rotating the upper prism—

are remarkably well formed; and on the whole this specimen is one of the best examples of the type-structure of the melaphyres of the district. It bears a close resemblance to the rock from the "Lion's Haunch," Arthur's Seat, near Edinburgh, of which I have had an opportunity of examining a section, kindly lent to me by Mr. Allport, F.G.S. With the quarter-inch object-glass well-defined cells were observed in the augite crystals.

7. *Specimen from Carrigogunnell.*—This specimen comes from an outlying district, separated from the Trap-bands by several miles of limestone. Its position is about 5½ miles W. of Limerick, and it is supposed to be contemporaneous with the "Lower Trap-band." The trap itself is interposed between beds of ash. The base, as seen with a high power (quarter-inch), consists of a highly crystalline triclinic felspar, containing ill-formed augite crystals, rounded or oval greenish grains (probably pseudomorphous after olivine), long prisms of triclinic felspar (probably Labradorite), and groups and grains of magnetite. The felspathic base is throughout highly crystalline, and is seen with the quarter-inch object-glass to contain numerous cavities, sometimes elongated, at other times oval or round.

Olivine (?).—An oval-shaped large grain, filled with a nearly colourless material, but having numerous star-like radiating centres and curved lines in green, resembles one of the figures of olivine structure given in Dr. Zirkel's work on the structure of basalts.[2]

Felspar crystals.—The long prisms of triclinic felspar are very like those of the Antrim dolerites, which are known to be formed of Labradorite felspar.

8. *Specimen from Knockea.*—Dark compact trap (forming boss supposed to belong to the Lower Trap-band).—Colourless base with slender prisms of triclinic felspar; large quantities of magnetite in crystalline grains, a few crystals of augite, and numerous grains and patches of a greenish mineral. The augite grains are exceedingly minute, and scarce.

Olivine (?).—Some of the greenish grains when examined with the quarter-inch object-glass show a radiating fibrous structure somewhat resembling that of one of the specimens of olivine figured by Dr. Zirkel; and on the whole, although the crystalline form of this mineral is often not at all, or only obscurely developed, I have little doubt that these grains are olivine, or its pseudomorphs.

9. Mottled dark purple amygdaloidal trap, Herbertstown (top of *Lower Trap-band*).—Base a colourless glass, sometimes stained brown, containing small prisms of triclinic felspar, and containing cavities sometimes filled with a green structureless mineral (chlorite?), but generally with calcite.

The slice is not sufficiently thin, and is so much stained by oxide of iron, that other minerals are not discernible. With polarized light the banded structure and opalescence of the calcite, which fills the fissures and cavities, is remarkably well shown.

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[1] See Explanation to Sheet 143, p. 25.

[2] Untersuchungen über die Mikroskopische Zusammensetzung der Basaltgesteine (1870).

(10). *Specimen from Knockdirk* (an outlying mass, considered to be a "root" or "neck" of one of the old vents).—This rock, as Dr. Apjohn has observed, is different from the other Trap-rocks of the district. He says, "On this hill is a close-grained greenstone, which graduates into a clinkstone possessing sometimes an olive green, sometimes a red, but more usually a brownish tinge."[1] The specimen in my possession from which the slice was taken is reddish in colour, and of a crystalline granular structure.

It consists of a colourless, or slightly stained felspathic base, with crystals of orthoclase, and grains of silica. There are also a few crystalline grains of magnetite, and irregular patches of green chlorite.

Silica.—As in the case of granite, the silica forms a paste in which the felspar crystals, as well as some of magnetite, are imbedded, and it was clearly the last to consolidate. Small cavities and cells may also be observed with the quarter-inch object glass. Some of these are in the form of long tubes extending in various directions through the mineral.

Felspar Crystals.—These I assume to be orthoclase from their frequent rectangular form, and the absence of bands or fine lines characteristic of the triclinic felspars. It was also to be expected that in a rock so highly silicated as this, orthoclase would be present. I could observe no augite crystals.

On the whole, it is clear from the composition and structure of this rock that it is altogether of a different species (or indeed genus) from the traps above described, and approaches more nearly to the composition of a trachyte, or clinkstone, than to that of a basalt or melaphyre. It is the only one in which silica appears as an essential constituent and in large proportions.

(11). *Specimen from Cahermarry.*—Glassy cellular base, amygdaloidal, tinged deep-green by chlorite (?), with some small prisms of triclinic felspar. Many of the cells are filled either with a green fibrous mineral (chlorite?) or calcite, or both. (Figs. 6, 7, 8.) The dark base is due to abundance of magnetite and chlorite.

The points specially noticeable in reference to the above specimens, which may be regarded as fair representatives of the Limerick Carboniferous melaphyres, are the following:—

1st. The glassy felspathic base with cells and tubes.

2nd. The small quantity of augite, this mineral only occurring in the form of scattered crystals or grains.

3rd. The abundant infusion of chlorite, or more rarely epidote, not only filling in cavities and interstices between the crystals, but also replacing, in many cases, the original minerals themselves (augite, olivine, etc.).

4th. The abundance of calcite, also due to percolation, and of secondary formation.

Antrim Miocene Basalts.—Considering that the rocks I have just described may be regarded as the more ancient equivalents of the Tertiary basaltic sheets, it may be interesting to compare their respective structures.

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[1] *Suprà cit.* p. 32.

I have examined a considerable number of sliced specimens taken from various parts of the Antrim trap-area, and it is remarkable that they all present a nearly uniform structure, notwithstanding different degrees of crystallization. In this case the augite, instead of being imbedded in a crystalline form in a colourless glassy base, is itself the base, inclosing prisms of triclinic felspar, grains of magnetite, or titano-ferrite, and sometimes olivine. Chlorite is also present, but not so frequently as in the Limerick melaphyres, and the whole rock is in a less altered state. Thus, if we compare the composition of the Limerick and Antrim traps, we would find that the relationship is somewhat as shown below:—

Relative proportions of minerals in the Melaphyres of Limerick and the Basalts and Dolerites of Antrim, Down, etc.

LIMERICK. *Carboniferous.*		ANTRIM. *Tertiary.*	
BASE. Colourless glass, containing	Augite crystals. Triclinic felspar, Magnetite. Olivine (Pseudomorphs). Calcite & chlorite (accessories).	BASE. Augite, containing	Triclinic felspar. Titano-ferrite. Olivine (sometimes). Chlorite (sometimes).

It will be thus seen that the relations of the minerals are quite different in each case, and it seems probable that this is due to the greater abundance of augite in the Antrim traps;—so abundant as to have itself become the base. In the case of the Limerick melaphyres the mineral occurred in such small quantities that it crystallized out in individual crystals, bearing a small proportion to the whole mass of the rock. This points to essential differences in the two magmas, involving some interesting chemical inquiries.

The distinction here stated between the structure of the Carboniferous and Tertiary augitic rocks (melaphyres and basalts) is not admitted by Mr. Allport, with reference to similar rocks of England and Scotland. Mr. Allport's opportunities of investigation, however, have been much larger than my own, and the result he arrives at may be thus summed up in his own words:—

"I have abundant evidence that melaphyres of undoubted Carboniferous age, and basalts of Tertiary age, have not only the same mineral constitution, but also that both present the same structural varieties."[1] My observations tend rather to confirm the opinion of Mr. Forbes, as expressed in his paper "Researches in British Mineralogy."[2] And the glass base of the Limerick melapyhres is in keeping with the general character of the basaltic rocks as described by Dr. Zirkel.[3]

EXPLANATION OF PLATE VIII.

FIG. 1.—Twin crystals of triclinic felspar, inclosing spangled greenish grains, probably of olivine. From Upper Trap-band, Ballytrasna.

FIG. 2.—Augite crystal, inclosing magnetite grains. From Upper Trap-band, Ballytrasna.

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[1] GEOLOGICAL MAGAZINE, Vol. VIII., p. 449.

[2] *Phil. Mag*, vol. xxxiv., p. 336.

[3] *Sup.* cit., p. 88.

FIGS. 3, 4, 5.—Crystalline grains of olivine replaced by chlorite, and inclosing (No. 5) magnetite crystals. From Upper Trap-band, Rathjordan.

FIGS. 6, 7, 8.—Cells in amygdaloid, filled with green chlorite (or epidote) and calcite. In No. 7 the green mineral has an excentric arrangement. The calcite is colourless, with a peculiar banded structure, and iridescent to pearly lustre. Cahermarry.

FIG. 9.—Portion of glass base—magnified about 200 diameters—showing tubes, cells, and belonites, and inclosing crystals of magnetite. From Upper Trap-band, Rathjordan.

FIG. 10.—Twin crystals of hornblende, brownish colour, inclosing magnetite grains. Lower Trap-band, Roxborough.

FIG. 11.—Pseudomorphous crystal after hornblende, the substance of the mineral replaced by chlorite or epidote, and calcite. Roxborough.

FIGS. 12–18.—Forms of augite crystals, or pseudomorphs, mineral sometimes replaced by chlorite and calcite, as in Figs. 12, 13, 14, 15, and 16; from Ballybrood. Fig. 17 represents a crystal of augite from Upper Trap-band, Ballytrasna. Nos. 13 and 15 are twin crystals.

The figures have been sketched by the hand direct from the microscope by the author.

IV.—NOTES ON THE GENUS *ROSTELLARIA* (OR *APORRHAIS?*) OF THE GAULT.

By J. STARKIE GARDNER, F.G.S.

HAVING read Mr. Price's note and description of *Rostellaria maxima* in last month's Number (p. 97, Pl. VI.), I venture to express my regret that so doubtful a species should be published with the apparent authority of the GEOLOGICAL MAGAZINE to confirm it; especially as Mr. Wiltshire (than whom there is no one better acquainted with English Cretaceous Mollusca) is of opinion that it is only a giant form of *Rostellaria carinata.* The description given by Mr. Price would equally apply to the ordinary form of *R. carinata* which occurs in the same bed, and, save in size, exactly resembles it. The most distinctive portion of the shell, the wing, is unfortunately not preserved. The examples of *Rostellaria carinata* found in this bed, I may remark, always differ slightly in form, being broader and more obtuse (they are also usually more crushed and imperfect) than those from the lower beds. I am fully convinced that, if *size alone* is sufficient ground to justify the formation of new species, we shall speedily find the present confusion of names in the Gault fauna more hopelessly involved and more impossible to unravel than ever. What, for instance, would be the result of the adoption of such a basis of nomenclature for the *Cephalopoda* from the same formation?

But, even if the species be allowed to remain, I cannot see how the publication of an isolated form can add materially to our knowledge, since no monograph of Cretaceous *Rostellariæ* has been published, and many of the comparatively common species are still imperfectly or improperly described.

While considering the subject of *Rostellaria*, I should particularly like to obtain the opinion of workers in recent and fossil conchology as to the advisability of adopting Da Costa's name of *Aporrhais* for the group, and whether it might not even be made to include *Pteroceras Fittoni* of the Lower Greensand, and *Pterocerus bicarinata* or *retusa* of the Gault. I subjoin an abbreviated translation of Pictet and Campiche's description of each genus:

1.—*Rostellaria*, Lamarck.

Shell pointed, prolonged, turriculated, the mouth terminated anteriorly by a thin rostrated canal; the lip forms a but little developed wing, which has on its margin small pointed teeth. The posterior angle of the mouth generally presents a canal contiguous to the spire. In all recent species there is a want of ornamentation; the surface is smooth or reticulated, but does not present prominent costæ, analogous to those which are so frequent on *Chenopus* and *Pteroceras*.

2.—*Aporrhais*, Da Costa. (*Chenopus*, Philippi.)

In the small number of species which are known the shell is turriculated spire, long or median, with a considerably expanded wing, more or less divided, and a variable anterior canal.

A comparison of the shells, which may easily be made at the British Museum, confirms the foregoing descriptions. It will be observed that all the species of the genus *Aporrhais* are strongly ornamented, and the difference in aspect will strike the most casual observer. Their separation has, I believe, been made on account of differences in structure of the animals themselves.

A careful and unbiassed examination will, I feel convinced, lead to the conclusion that all the Gault *Rostellariæ* should be named *Aporrhais*, for they undoubtedly bear considerably more resemblance to *Aporrhais pes-pelicani* and *A. occidentalis*, than they do to any of the *Rostellariæ*. Indeed, they are even more like *Pteroceras* than *Rostellaria*, and can often only be distinguished from the former by the length of their spire.

I have ventured to subjoin a list of the species from the Gault in my collection. I shall be happy to place them at the disposal of and to assist any practical palæontologist who desires to give a really exhaustive account of this most interesting group, which seems to have reached its maximum development at this period of the Cretaceous epoch. The species are best preserved and most abundant at Folkestone. It must be understood that the following is a hurried list, and merely provisional. The subject wants most careful treatment and illustration from perfect specimens existing in different cabinets. If it serves to provoke discussion and call attention to the group, my object will have been attained.

1. *Aporrhais* (Pict.) *carinata*, Sow.
2. *Aporrhais Orbignyana*, Pict. et Roux (qy. *A. obtusa*, Pict.) *R. costata* of Michelin, but described under a false assimilation with a different species found at Gosau. Very abundant.
3. *Aporrhais Parkinsoni*, Sow. Much confusion has arisen from different species having been figured by Mantell, Sowerby, and D'Orbigny under the same name. According to strict precedent, the species figured by Parkinson, and known to English geologists as *R. Parkinsoni*, has the priority, and should be retained instead of *R. Reussii*, *R. buccinoides*, etc.
4. *Aporrhais calcarata*, D'Orb. (and qy. *A Muleti*, d'Orb.). A small species, also common at Blackdown.
5. *Aporrhais carinella*, D'Orb. A smooth species, figured by D'Orbigny in Pal. Fr., but imperfect in his figure.
6. *Aporrhais*, a distinct elongated species, the *elongata* of Sowerby, Geol. Trans., 2nd ser., vol. iv., pl. xi., fig. 17, appears to be a *Scalaria*. I should propose to retain the specific name *elongata* for this species.

7. *Aporrhais cingulata*, S. P. Woodward. Strongly and regularly transversely ribbed, without tubercles or longitudinal costæ. S. P. Woodward claimed this as a new species, but Pictet and Roux had already figured a very similar but imperfect specimen from the Gault under this name.
8. *Aporrhais*, spec. nov. A small pupæform species, with two keels on the body-whorl, and one keel on each of the remaining whorls, and marked with longitudinal ribs wide apart. Anterior rostrated canal longer than the rest of the test, and large-winged prolongations from the lip.
9. *Rostellaria*, or possibly *Fusus*. Smooth but very finely transversely striated. All the specimens have the body-whorl imperfect, but have the prolonged rostrated canal.
10. *Pteroceras retusa*, Sow. *Pterocerus bicarinata*, D'Orb. An abundant and well-marked species.

R. marginata, Sow., Geol. Trans., 2nd ser., vol. iv., pl. xi., fig. 18, is evidently *R. carinata*. Both Pictet and Campiche and Pictet and Roux refer to it, but figure a different species, with the ornamentation of a Gault *Scalaria*. The rest of the species figured by D'Orbigny and other foreign writers do not occur, as far as I can ascertain, in the Gault of Folkestone.

V.—On some Points connected with late Glacial Action and Raised Sea-beds.

By the Rev. O. Fisher, M.A., F.G.S.

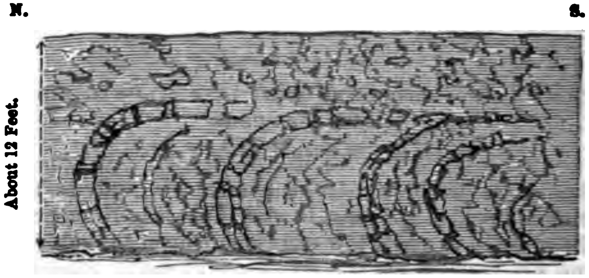
My thanks are due to Mr. Tiddeman for his reply to the letter from me, which appeared in your February Number. I may perhaps be allowed to add a few words more upon the subjects under discussion.

There is an error in my former letter, which gives a wrong impression of my views upon the subject of the Trail. I originally used that word in 1866, to designate the disturbed ground commonly found below the subsoil or warp. I am made to say that it is "none other than the river gravels." I certainly intended to write that "it is newer than the river gravels."

Mr. Tiddeman is nearly correct in saying that I use the word in question to designate the "till" of a particular period. More exactly I use it to designate a particular accumulation of disturbed ground, which certainly exists; and I think it will be best to reserve the name for that deposit. It expresses no theory about the causes which produced it, but only implies that it has been dragged along, which has evidently been the case. It is true that I myself regard it as the *moraine profonde* of a particular period, to wit, of the last covering of ice upon this country. I do not mean to imply, however, that this was of the age of the ice-sheet of Lancashire, but simply wish to inquire whether it may not have been contemporaneous with the laminated clay of the Settle Cave; not understanding Mr. Tiddeman as fixing the age of that clay. In it I think I recognize an instance of ice-action subsequent to the cave-and-river period, and fitting to my theory. My protest against the expression, "*The* glacial period," was a general one, as too indefinite; and I have no intention of claiming the great ice-sheet (about which I am not well informed) as synchronous with the Trail. For I suppose that the marine glacial clay of Hollingworth, near Manchester, is one of the deposits, newer than the ice-sheet, to which Mr. Tiddeman refers.

I observed there that the minor features of the surface contour are carved out of it and the Millstone-grit alike, which on my theory would make the last general denudation, and therefore the Trail, newer than that clay, and *à fortiori* newer than the ice-sheet and its till.

I must admit that I cannot find a statement, as direct as I supposed, of my opinion that the overturning of the basset edges has been caused by the passage of ice over them. But I have implied this in a letter to the MAGAZINE, Vol. V., p. 36. Mr. Tiddeman has given a diagram[1] where this phenomenon is connected with acknowledged till, and refers the former to the ice which deposited the latter. I can mention instances where there is no till usually so regarded, and yet this action upon the basset edges is undeniable.



Reversed laminæ of Schorlaceous Granite south of Carclaze Mine, Cornwall.

One of these I saw last summer in Cornwall, in a cutting on the south side of the famous Carclase mine near St. Austell's. The granite there is greatly disintegrated, and used for china clay. But it is traversed by joints whose walls are schorlaceous and much less decayed. The result is that the entire mass simulates stratification, which is nearly vertical. It was in this that I observed the reversal of the edges of the laminæ, which are bent over towards the south, that is towards the brow of the hill, until they become horizontal. The spot is sufficiently distant from the brow of the hill for the declivity of the ground to be very small, but I think the neighbourhood of the brow has something to do with the effect. The disturbed layer is about four feet deep.

Another instance I noticed in Dorsetshire some years ago. It occurred in a large pit, excavated in Eocene gravel, immediately above the tunnel of the Dorchester and Weymouth railway at Ridgway Hill. The gravel, which is distinctly stratified, and thrown by the great disturbance at that place into a vertical position, has its layers bent over towards the brow of the hill in a manner exactly similar to the case already described as occurring near St. Austell's.

Another instance may be cited from Torquay, where the edges of the Devonian shale, in a quarry by the roadside, just above the Post office, are turned over in a most marked manner. But here the rocks are on the side of a steep declivity, and the old explanation of the "weight of the hill," that is of the tendency of the surface to slip downwards under the influence of frost, might be applied.

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[1] Geol. Journ., vol. xxviii., p. 481.

In none of these cases is there any Boulder-till properly so called in the vicinity.

This phenomenon, and also the Trail, have no doubt an important bearing upon the great question of denudation. I have attributed them to glacial action. But the theory is surrounded with many difficulties, and I am very anxious to see the question discussed by others from the point of view which takes special account of the condition of the disturbed subsoil.

Mr. Tiddeman tells us that the period of the great ice-sheet "was succeeded by a period of depression, well marked by marine sands and gravels up to 600 or 700 feet in North Lancashire." Without attributing such views to Mr. Tiddeman, I may ask whether it has not been customary to argue from local deposits at high levels, to general depressions of the land over larger areas than the observations warrant? And still further, whether a distinction has been preserved, as it ought to have been, between changes of relative level, caused by elevation and depression of the land owing to intrinsic motions of the earth's crust, and changes in the depth of the sea, such as might be due to the attraction of accumulations of ice, or other causes disturbing the water-level? The latter would clearly affect larger areas than the former, though the variation of level might often be less. And I felt this when in my paper on the warp I described the last change preceding the recent period by saying, "The sea was then depressed again, and the recent period commenced."[1]

Mr. Tylor gives expression to a similar opinion in his late paper on Denudation,[2] and tells us that there has been a great elevation of the land "along a certain line; lifting marine beds 1200 feet at one point. The movement was 350 feet in Lancashire, 200 feet at Coalbrookdale, and thence gradually ceasing." He also remarks that the *Cyrena* sands "in the Thames and Humber valleys reach the same height within three or four feet, and are all under the fifty feet range at the present time," and "a rise in the sea" of fifty feet would immerse them.

In fact, it seems to me that the strata of our island have long oscillated at intervals, as if hinged about a line somewhere near the eastern coast, and parallel to the general strike of the Mesozoic rocks; and that, in consequence, the more recent deposits are found at a much greater altitude on the western side than their correlatives occupy on the east. To the same cause I should attribute the tame character of the scenery of the south-eastern district north of the Weald. The Chalk and Oolites are not more easily denuded here than elsewhere, yet the hills which they form are lower. The rocks of Charnwood forest are sufficiently hard to form lofty hills; but they do not rise more than 1000 feet, and rarely to that height. On the other hand, atmospheric agencies are, and must always have been, more powerful for denuding on the west, where more rain falls, and in glacial periods there would no doubt have been more snow. May not the explanation of these facts be, that the western side has gone up higher within some late period: so that although denudation has gone on, perhaps even more rapidly, upon its hills, they nevertheless remain more lofty, because the altitude requiring to be reduced since that time has been more considerable?

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[1] Geol. Journ., vol. xxii., p. 564.

[2] Geol. Mag., Vol. IX., p. 395.

VI.—SUPPLEMENTARY NOTE ON MINERALS FOUND IN SOMERSETSHIRE.[1]

By SPENCER GEORGE PERCEVAL.

AGATES are found abundantly in Somersetshire. Dr. Buckland mentions their occurrence at Sandford, near Banwell, Worle, and Clevedon. Trans. Geol. Soc., ser. 2, vol. iii., p. 421. See also Sowerby's British Mineralogy, vol. v., 1817, p. 213.

Copper occurs in a conglomerate quarry behind the village of Alcombe, near Minehead.

Fluor spar occurs at Clifton, in the Great Quarry on the Gloucestershire side of the Avon, in the form of small purple cubes, in cavities of the Mountain Limestone, lined with crystals of Calcite and occasionally of Pearl spar: also on the Somersetshire side of the Avon section.

Bitumen also occurs (liquid and consolidated) in adjoining cavities in the Mountain Limestone.

NOTICES OF MEMOIRS.

I.—ON THE FORMATION OF MOUNTAINS.[2]

By Captain HUTTON, F.G.S., C.M.Z.S.

> "We must never forget that it is principles, and not phenomena—the interpretation, not the mere knowledge of facts—which are the objects of inquiry to the natural philosopher."—SIR J. HERSCHEL.

THE formation of mountains does not very well describe the subject on which I propose to lecture to-night, for, strictly speaking, mountains are formed by rain and snow sculpturing and grooving what would otherwise have been table lands, or the highest portions of the undulations of the earth's surface; but on this subject I do not mean to touch. I propose to deal with the undulations themselves, out of which mountains are carved by the rain.

It is well known that the solid surface of the globe is uneven and undulating, that the lower portions are covered by the ocean, while the higher are called the land, and it has also been proved, by observations extending over nearly a century, that these undulations have changed in form and position over and over again, and that changes are still going on. That the solid surface of the earth should heave and quiver, and sway up and down, is one of the most extraordinary phenomena of nature with which science has made us acquainted, and it is one which has never yet received a satisfactory explanation. I hope, however, to be able to show you that it is but the necessary effect of causes which we know from observation to be constantly going on on the surface, combined with the conduction outwards of the interior heat of the earth.

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[1] See list by H. B. Woodward in GEOL. MAG., Vol. IX., March, 1872.

[2] Substance of a lecture delivered in the Colonial Museum, Wellington, New Zealand, 13th November, 1872.

In order to make what I have to say quite clear to you, I must first briefly refer to some general considerations on the interior of the earth. Fortunately, it will not be necessary for me to enter into the hotly disputed question as to whether it is fluid or solid, for this is immaterial to the views that I have to advance; all that is necessary being that the interior is very hot. This is allowed, I believe, by all scientific men, the proof resting principally on the facts that we know from observations, wherever they have been made, that the temperature actually does rise as we descend, at an average rate of about 1° Fahr. for every fifty feet, and that the density of the earth is so small, not much more than twice that of the ordinary rocks of the surface, that there must be some expansive force in the interior sufficiently powerful to balance in a great measure the enormous pressure to which the interior of the earth would be subjected. Assuming then that the interior of the earth is intensely heated, and that the temperature, for a depth say of fifty miles from the surface, increases at the rate of 1° Fahr. for each fifty feet, it necessarily follows that the outer shell, or "crust," as it is commonly called, to a depth of somewhere about thirty-five miles, has a temperature below the melting point of ordinary rocks at the surface, while all below this depth has a temperature above its melting point at the surface. Consequently, we have an outer crust in which the attraction of cohesion among the molecules is greater than the repulsion caused by heat, surrounding a nucleus in which the repulsion caused by heat among the molecules is greater than the attraction of cohesion.

The outer crust must therefore be more or less rigid, while the superheated interior must be in such a state that if the pressure that keeps it in its place is decreased at one point it will expand, and this expansion will permeate through the whole mass until the pressure is again equally distributed throughout. Conversely, if the pressure is increased on any point, this pressure will affect the whole mass and distribute itself evenly through it. Of course I need hardly say that the rigid state of the crust is not separated from the superheated state of the interior by a marked division, but the one passes imperceptibly into the other. Now each portion of this rigid crust must be maintained in its place by three forces, viz.—its weight, the lateral thrust of the arch, and the outward pressure of the superheated interior. While these three forces remain constant, equilibrium will be maintained, and no movements will occur on the surface. But if one or more of these forces change in amount, the equilibrium will be subverted, and movements of the surface will take place. If also the equilibrium be disturbed at one place, it follows, from what I have said about the distribution of pressure in the superheated interior, that the equilibrium will also be disturbed in all surrounding areas. If, for instance, an upheaval of the crust should take place at any point, the underlying superheated rocks, being thus relieved from the pressure above them, would expand and rise up, and fill the hollow; but this expansion would spread through the mass, and would therefore lessen the outward pressure of the interior in all the surrounding areas, which would consequently subside, and equilibrium would only be once more restored when the mass of the subsided areas equalled the mass of the elevated areas. Consequently elevation implies subsidence, and *vice versâ*. Where now must we look for the causes that are in operation to disturb this equilibrium? The most obvious is the radiation of heat into space by the earth, and the consequent cooling and contraction of the superheated interior. This is at present almost universally accepted by geologists as the cause of the movements of the surface and the upheaval of mountain chains, but many arguments have been urged against it, and although I am willing to allow that it must have some effect in producing movements, these effects are, I think, completely absorbed by the much larger ones that flow from causes that I shall presently describe; and it is quite impossible that it can be the only cause of movement, partly because some effect must be produced by the other causes that I have yet to describe, and partly because since the Glacial epoch the earth has been warming instead of cooling, and consequently no contraction can have taken place since then, while we know not only that extensive movements have taken place, but that they are still taking place on the surface of the globe.

The other cause of disturbance of the equilibrium, to which I have alluded, is the removal of matter from one portion of the earth by running water and its deposition on another portion. It is now nearly forty years ago since Mr. C. Babbage, in his celebrated paper, read before the Geological Society of London,[1] on the temple of Jupiter Serapis, proposed a theory to account for oscillations of the surface of the earth, which he called the theory of "the change of isothermal surfaces." At about the same time, Sir J. Herschel, in a letter to Sir C. Lyell,[2] proposed to account for the same phenomena by a theory which he called "the alteration of the incidence of pressure." Both these theories are founded on the same fact, viz. the removal of matter from one portion of the earth's surface and its deposition on another; but while Mr. Babbage laid the most stress on the changes of internal temperature that would be thus brought about, Sir J. Herschel laid the most stress on the change of direct pressure, or weight. These theories have never been taken up by geologists, but I hope to be able to show to you that, when combined, they are capable of explaining all, or nearly all, of the observed phenomena. I have already told you that, owing to its internal heat, the mean temperature of the earth increases as we descend into it at the rate of about 1° Fahr. for every fifty feet. If, therefore, the mean temperature of the surface at any place was 50° Fahr. the mean temperature 100 feet below would be 52° Fahr. If now the surface was covered up by a deposit of clay or sand 100 feet thick, and if its surface retained the same mean temperature as the old one, viz. 50°

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[1] Quart. Journ. Geo. Soc., iii., p. 186.

[2] Proc. Geol. Soc., ii., pp. 548, 596.

Fahr., the mean temperature of the old surface would be raised 2°, or to 52°, while at 100 feet below it would be 54°, and so on, so that the covering of the surface by a deposit 100 feet thick would raise the temperature of the whole underlying rocks 2°. If the deposit was thicker, the temperature would of course be more raised in proportion. Now we know that rocks expand on being heated,[1] and contract on being cooled, and Colonel Totten and Mr. Adie have shown that this expansion for each degree of temperature is from $\frac{1}{35000}$ to $\frac{1}{100000}$ of the whole, according to the nature of the rock. If, however, the deposit was unconsolidated, like clay or sand, and the particles were free to move among themselves, this expansion would have very little effect in raising the surface; but if the deposit was rigid, like limestone, the effect would be totally different, and the irresistible pressure, caused by the expansion of the rock, could only be relieved by the whole stratum bulging upwards and forming an arch, or more properly a dome; and as we know the rate of expansion, we can calculate what the elevation would have to be on a sphere the size of the earth, for various temperatures and for different areas, in order to relieve the pressure. This is exhibited in the following table, which is part of a larger table that I have calculated.[2] In it the upper line is the thickness in feet of the deposit, while the second line is the temperature due to that thickness. The left-hand column is the diameter, or breadth, in miles of the heated area, while the other columns show the elevation in feet that would take place:

Thickness	500 feet.	2,500 feet.	10,000 feet.	25,000 feet.
Temperature	10°	50°	200°	500°
Breadth, 100 miles ...	1,140 feet	3,700 feet.	8,700 feet.	14,600 feet
" 500 " ...	1,550 "	7,220 "	24,200 "	49,300 "
" 1,000 " ...	1,570 "	7,700 "	28,600 "	65,400 "
" 2,000 " ...	1,900 "	7,800 "	30,700 "	74,400 "

From this table it will be seen that formations no thicker nor more extensive than those that we know to have been deposited, are quite capable of being elevated far above the highest known mountains.

It may have occurred to you that a bed of limestone would not be capable of supporting itself as an arch, and, therefore, that instead of being elevated it would break up into fragments; this is very true, if the arch was entirely unsupported, but as soon as the expansion overcame the rigidity of the crust, and movement commenced, the underlying superheated rocks, being relieved from pressure, would rise up and still press upwards on the rising arch, so that the pressure expended in elevation would be that capable of overcoming the rigidity only of the crust, and not its weight. You may also have noticed that unless the rate of deposition was greater than the rate of the conduction of heat outwards, no deposit would rise above the surface of the sea, for as soon as deposition ceased the increase of temperature would cease also; and conversely, the greater the difference between the rates the greater would be the rise, for the longer would be the time before the deposit attained its normal temperature.

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[1] Clay contracts on being heated, but this does not affect the theory.

[2] This table is calculated on the suppositions that the earth is a sphere, with a radius of 3956 miles, and that rocks expand ·000005 for 1° Fahr.

The data to estimate these rates are not very exact, more especially the rate of deposition, but the following is the best information that I can collect:—

Monsieur Joseph Fourier has calculated that the earth decreases in temperature by radiation 1° Fahr. in 3,000,000 years,[1] and from this we can deduce that the conduction outwards must be about one-tenth of an inch a year. Sir W. Thomson's calculations, founded on experiments made at Edinburgh, Greenwich, and Upsala, give an outward conduction two and three quarter times as fast; but these experiments were made on dry rocks, and he allows that if the rocks were saturated with water, as all newly-formed deposits would be, his estimate would have to be reduced by one-half; which would then give an outward conduction of one-eighth of an inch per year. Peclet's experiments show also that the conductivity of limestone is only two-fifths of the average taken by Sir W. Thomson, or one-tenth of an inch per year. Consequently, we cannot be far wrong if we take the average conductivity outwards at one-ninth of an inch per year.

Professor Dana has estimated that limestone grows at the rate of one-eighth of an inch per year, and sandstone five to ten times as fast, or from five-eighths to one and a quarter inch per year; while the average increase in thickness of the clays of deltas appears to be about one-fifth of an inch per year; so that if we suppose a formation to be about one-third limestone, we get an average rate of deposition for the whole formation of one-third of an inch per year, or three times as fast as the conduction of heat outwards.

If at the present time the internal heat travels outwards at the rate of one-ninth of an inch per year, it would take 54,000 years to heat a deposit 500 feet in thickness; but a deposit 500 feet in thickness implies a rise of temperature in the underlying rocks of 10°, which implies an elevation of 1,140 feet if the heated area was 100 miles in diameter, or 1,900 feet if it was 2,000 miles in diameter, consequently in the first case the land would have risen 1,140 feet, and in the last 1,900 feet in 54,000 years, or at the rate of from two to three and a half feet per century, which is just the rate that Sir C. Lyell considers as most probable from observation.

But in former times when the internal temperature increased three times as fast as it does now, or 1° for seventeen feet, the conduction outward would be equal to the deposition, and consequently no land could rise above the water, and this may have been the cause of the "insular condition" which seems to have prevailed over the world during Palæozoic times. According to the theory of the secular cooling of the earth, advocated by Sir W. Thomson, these conditions must have occurred about eleven and a half millions of years after the formation of the crust, or about eighty-eight and a half millions of years ago. From that time to the present, elevation must have gone on in an increasing scale; but, although increasing in height, it must have also been decreasing in rapidity, and a time must inevitably arrive when elevation will be so slow that it will do no more than equal denudation, and when again, therefore, no more land can rise much above the surface of the sea. Now, it has been estimated that a foot of soil is removed by denudation in from 500 to 12,000 years, according as the land is mountainous or level, and if we take the lowest estimate as that which will be nearest to the conditions at the time I am talking about, we find that the interior heat would have to increase at the rate only of 1° in 10,000 feet to bring about the result.[1] This, by Sir W. Thomson's theory, will not be for thirteen billions of years; so that the earth is but in its infancy between birth and the repose of old age, and we have plenty of time to look forward to for improvement and development.

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[1] Theorie de la Chaleur, Paris, 1822.

But leaving these speculations, it is, I think, time that I gave you an illustration of the theory. I select the Wealden District in the South of England. This district extending through Kent, Sussex, and Hampshire, is formed by an anticlinal curve of the Cretaceous and wealden strata. The thickness of the beds is 3,400 feet, and the highest part of the arch would have attained, if the upper portion had not been denuded off, a height of about 3,600 feet above the sea. The base of the arch below London is about 500 feet below the sea, so that the total rise of the arch must have been about 4,100 feet, while the breadth of the anticlinal from London to some point in the English Channel is about 100 miles; these, therefore, are our data. Now a thickness of 3,400 feet implies an elevation of temperature of 68°, and this over a breadth of 100 miles would give an elevation of 4,650 feet, that is to say 150 feet more than the actual rise. But as the land rose above the sea denudation would commence to work upon it, so that the temperature would not be able to rise the whole 68°, and this will account for the 150 feet which the anticlinal arch failed to attain.

I will give you another and more general illustration. During the Eocene period a large ocean, at least 5,000 miles long by 1,800 broad, extended over the south of Europe and the north of Africa, and was continued eastward through Asia Minor, Persia, and Northern India to China. In this ocean, what is known as the Nummulitic Limestone was formed to a thickness of 15,000 feet. Consequently if, as I have said, large limestone deposits produce elevation, it is here that we ought to find the evidence of it; and this we plainly do in the Atlas, Pyrenees, Alps, Apennines, Carpathians, Himalayas, and the mountain chains of Persia; we find, in fact, that the area of the Nummulitic Limestone embraces the most mountainous country in the world, and geology shows us that these mountains are all about the same age, and all have been elevated since the period of the Nummulitic Formation. A thickness of 15,000 feet of limestone over an area 1,800 miles in breadth is also more than sufficient to elevate into the air the most towering peaks of the Himalaya.

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[1] I need hardly say that these numbers are introduced as an illustration merely, and make no pretension to *accuracy*.

I might also adduce the Appalachian mountains in America as a beautiful illustration of the theory, every elevation that has taken place distinctly following the deposition of limestone, and occurring only where the limestone was deposited, except, perhaps, the last elevation after the Carboniferous period, which at present I cannot account for—for, according to American geologists, the Carboniferous Limestone never overlaid these mountains. But, besides the deposition of matter, any other cause that changed the temperature of the surface, would also produce alterations of level—a rise in the temperature being followed by elevation, and a fall by subsidence owing to the cooling and contracting rocks forming part of the surface of a sphere. In this way, the Gulf Stream, by raising the temperature of Norway and Sweden, is causing them to rise; while the cold Arctic current, sweeping down through Baffins Bay and striking against Greenland, is causing that country to sink.

Turning now to the second cause of the subversion of equilibrium, viz. change in the incidence of pressure, we find our data not so satisfactory, for we have no means of estimating the rigidity of the crust, and therefore of the weight it would bear before beginning to move, but nearly all geologists agree that most thick formations of sandstones and clays have been deposited upon a sinking area, and that in a large number of cases the subsidence has been approximately equal in rapidity to deposition. Now the chances are, of course, enormously against subsidence being equal to deposition, unless one is caused by the other, and when many cases of the kind are brought forward, our former suspicion becomes almost a certainty. This, of course, only applies to clays and sandstones, for I have already shown that limestones, as soon as they begin to expand, by heat, rise up and relieve the pressure; but with unconsolidated beds, like clay or sand, the horizontal thrust could never get powerful enough to overcome the rigidity of the crust, and consequently they could never rise.

As large deposits of limestone, therefore, elevate areas, so large deposits of argillaceous strata depress them. But while argillaceous strata are being formed they will not only be compressed by the sinking of the spherical surface on which they rest, but they will also at the same time be expanded by heat, and these two, together, will throw the beds into folds or contortions.

If we suppose that the subsidence is equal to the thickness of the formation, which is the most reasonable supposition that we can make, we can calculate the amount of compression due to sinking, and to expansion from heat, due to different thicknesses. Some of these are given in the following table, the upper line of which represents the thickness of the formation in feet, and the lower the proportionate compression:—

Thickness	5,000 feet	10,000 feet	20,000 feet	25,000 feet
Compression ...	$\frac{1}{1000}$	$\frac{1}{500}$	$\frac{1}{300}$	$\frac{1}{200}$

A first inspection of this table will give the impression that these compressions are not nearly enough to account for the contortions we see in mountain districts, but I believe that our ideas of contortions are very incorrect, owing to the necessarily exaggerated sections that accompany geological descriptions. The only sufficiently accurate section that I have been able to see is Professor Ramsay's beautiful section through Snowdon, in North Wales, and after carefully measuring it, and allowing for the faults and intrusive rocks, I find that the compression in this mountainous district is one-sixteenth. We must also remember that the contortions that we now see are the sum of all the compressions that have taken place at various times, for the rocks after being bent do not straighten out again on being stretched, but elongate by faulting. A considerable amount of the contortions of the lower beds of a formation will also be a necessary consequence of elevation by expansion, for during elevation the lower beds will not be able to expand so much as the upper ones of the arch, although much more heated.

The subsidence of an area caused by the weight of newly-deposited matter will compress the underlying superheated rocks, and, as explained at the commencement of the lecture, this will cause an increase of upward pressure in the surrounding areas. This increase of upward pressure will cause elevation in the surrounding districts, the rocks will be subjected to tension, and fissures will be formed. Up these fissures the superheated rocks of the interior will rise, and if they reach the surface will form volcanoes and overflow as lava streams. In this way mountains of quite a different character to those we have lately considered will be formed.

I have now explained to you the theory of Messrs. Herschel and Babbage in its simplest form, but in nature we should rarely find this simplicity. These two great powers—expansion by heat, and increase of weight—would sometimes combine and sometimes interfere with each other. Complications would also arise from the different degrees of fusibility, conductivity, porosity, and expansion of rocks, while the changes in physical geography caused by the changes in the position of the land would constantly alter the mean temperature of the surface, so that very complex phenomena might result from these simple causes.

To sum up. Mountain chains are of two kinds. The first, of which the Alps may be taken as a type, are composed of folded and contorted strata, generally associated with metamorphic and granitic rocks. These have been formed by heavy argillaceous deposits, causing subsidence and contortion, which have been subsequently elevated by the superposition of calcareous beds. The second kind, of which the Andes may be taken as the type, are composed of nearly horizontal strata, generally associated with volcanic rocks.[1] These have been formed by the upward pressure of the underlying rocks caused by the subsidence of adjoining areas, and owe their height partly to this upward pressure, but often in great part to the overflowing of the superheated rocks on the surface.

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[1] See also Darwin "On Volcanic Phenomena in South America."—Trans. Geol. Soc., 2nd series, p. 601.

There is, however, one other point that has still to be taken into account. If we calculate the mass of the ocean we shall find that it is sufficient, if the surface of the earth were level, to cover it entirely to a depth of at least two miles. Now, if it is true that the earth has been formed by the slow condensation of gaseous matter, we can see no possible reason why any of the gaseous materials should be confined in the interior solidifying portions, and by their attempts to escape cause eructations, or bubbles that could raise any part of the solid mass more than two miles high. In other words, I do not see how there could be any boiling or swelling up sufficient to form land above the surface of the ocean. If then there was no land in this primeval ocean for denudation to act upon, what was it that first disturbed the equilibrium of the crust and so led the way to those stupendous changes that we know have since taken place? But one answer can I think be given to this question, viz. *the origin of life*. Chemists are agreed that carbonate of lime was in solution in this primeval ocean, and when life, or rather life capable of secreting carbonate of lime, appeared, it would abstract this substance out of the ocean and deposit it on particular areas, and thus, by disturbing the equilibrium, would prepare the world to be the habitation for those countless myriads of organized beings which now swarm over it.

I will hazard one more supposition. Over this primeval ocean the winds must have swept with great regularity, and currents must have followed in their wake. Now these currents would naturally take two directions, one N.E. and S.W., and the other at right angles to it. If, therefore, we suppose life to have originated at any one point, it would gradually spread in a N.E. and S.W., or N.W. and S.E. direction, and the first calcareous deposits, and consequently the first land, would take these directions also. This would give the direction of other deposits, and although much obliterated by the complications that have since taken place, we can possibly, even now, trace in the directions of our mountain chains some remnant of this primeval arrangement. But this is sheer speculation.

Such is an outline of what I propose to call the Herschel-Babbage theory, after the two distinguished philosophers who originated it; it has the advantage over all other theories of the same nature of being capable of being proved or disproved by observations in the field. When firmly established, as I believe it will be, it will throw a new light on geology, for it gives significance to the thickness and composition of every rock, and to its geographical position; it gives significance to every bend and fold in the strata, to every fault and volcanic dyke; and it will also be found to furnish us with a key that will decipher many of the hitherto obscure passages in geological history.

II.—The Antiquity of Man in Britain.[1]

By James Geikie, F.R.S.E., F.G.S.,

District Surveyor H.M. Geological Survey of Scotland.

MR. GEIKIE, after some introductory remarks, in which he dwelt pointedly upon the great advance made within recent years in our knowledge of prehistoric times, went on to say that what he proposed to do on that occasion was to bring before his audience in a general way the evidence which had weighed with archæologists and geologists in assigning to man a much greater antiquity than had at one time been allowed. Thereafter he should attempt to sketch in outline certain investigations of his own, which enabled him, as he thought, to give a greater precision to our views of that antiquity, and this to such a degree that, with the help of the astronomer and the physicist, he believed we should eventually arrive at some approximate estimate of the number of years which had elapsed since the earliest savage tribes of whom we had any trace first occupied the caves of England. Mr. Geikie next proceeded to describe how archæologists had arranged under three groups all the monuments and memorials of man that belonged to prehistoric times. The oldest relics were rude implements of stone; next in point of antiquity came articles of bronze, and these were succeeded by relics made of iron. Hence arose the terms Stone Age, Bronze Age, and Iron Age. He cautioned his hearers, however, against supposing that any hard and fast line separated these three ages. Each undoubtedly flowed into the one by which it was succeeded. With the ages of bronze and iron the geologist had but little to do, they lay chiefly within the domain of archæology. It was quite another matter, however, with the stone age, the history of which could be worked out only by the geological method. The Stone Age was subdivided into two periods, termed respectively the neolithic or new stone period. and the palæolithic or old stone period. To the neolithic period belonged those implements and weapons which are often more or less polished and finely finished, and which, in variety of form and frequent elegance of design, evince no small skill on the part of the old workmen. These relics, he remarked, occurred throughout the whole length and breadth of the land, from the south of England to the north of Scotland, and they abounded in Ireland. As a rule they were met with at or near the surface of the ground, and were often associated with the remains of such animals as sheep, horse, dog, pig, and certain species of oxen. The weapons and tools of the palæolithic period were of altogether ruder form and finish. They were merely chipped into the requisite shape of adze, hatchet, scraper, or whatever the implement might chance to be. Although some dexterity was shown in the fashioning of these rude implements, yet they certainly betokened much less skill than the relics of the neolithic period. He remarked that an experienced archæologist had no difficulty in recognizing and distinguishing palæolithic implements at once from relics of the neolithic age. They found no tools or implements of intermediate forms that might indicate a gradual improvement and progress from the rude palæolithic types to the polished and elegant implements used by neolithic man. The one set of tools was sharply marked off from the other. The conclusion could not be resisted that the people who used the palæolithic implements were much less advanced, and decidedly inferior in mechanical skill and contrivance to the race or races by whom the polished implements were fashioned. A distinct passage could be traced from the new stone period into the bronze age; but between the disappearance of palæolithic man and the advent of neolithic man there occurred a blank which the ingenuity of archæologists had hitherto failed to bridge over. The lecturer then proceeded to describe the positions in which palæolithic implements were found, viz. in caves and in ancient river gravels. As a good example of the former he instanced Kent's Cavern in Devonshire, and gave some details as to the mode in which the implements were associated with the remains of extinct mammalia upon the floor of that cave, all buried under a thick cake of stalagmite. The special proofs of the great antiquity of this cavern-deposit were pointed out, the lecturer remarking that now no one who was competent to judge doubted that the animal remains and the human relics both belonged to one and the same period or periods. The mammalia he classed under two divisions—first, species which lived, and many of which are still living, under arctic conditions; and second, species which are either now denizens of temperate and warm regions, or have in those zones their nearest representatives. The first group embraced such animals as the reindeer, glutton, musk-sheep, etc. The second group contained the horse, wolf, wild-cat, extinct cave-bear, Irish deer, and so forth—all being species characteristic of temperate climates; while as representatives of warm climates we had two species of rhinoceros, the elephant, the hippopotamus, the lion. the hyæna, and others. Mr. Geikie insisted that this commingling of arctic and southern species pointed to former changes of climate, and not, as some had supposed, to a period of strongly contrasted summers and winters, during which great migrations took place. Such a climate could not possibly obtain in Europe under the geographical and physical conditions which are known to have existed during pleistocene times. He then recapitulated the geological evidence furnished by cave deposits, and showed that nowhere did the palæolithic deposits pass up gradually into neolithic accumulations. On the contrary, there was a sharp and abrupt break between the older and the later deposits. The evidence relating to the ancient river gravels was next taken up. The position of these deposits was described, and the mode of their formation indicated by means of diagrams. The occurrence in these ancient river beds of palæolithic implements, and the remains of extinct and no longer indigenous mammalia, furnished evidence in regard to changes of climate of precisely the same nature as that supplied by the cave-earths and breccias. It was also clearly proved by the river gravels that palæolithic man entered Britain ages before the valleys in the south of England were hollowed out to their present depth—that during his long occupation the rivers succeeded in cutting out the valleys to their present depth and breadth—and that not until this was effected did palæolithic man disappear and neolithic man take his place. No neolithic remains occurred in the ancient river gravels. The evidence of these gravels thus bore out that which was furnished by the caves and by a comparison of the two sets of stone implements themselves, and all combined to show that a decided and well-marked break separated the palæolithic from the neolithic period. What, then, was the nature of this break? What caused palæolithic man and the old pachyderms to disappear at once and altogether before neolithic man and an almost totally different group of animals entered the country? To answer this question it was necessary to consider the deposits belonging to that wonderful period which was known as the Ice Age, or Glacial Epoch. By means of maps and diagrams the lecturer then pointed out the salient features of the evidence under this head. He described a number of sections representing glacial deposits in Scotland, Switzerland, and North America, and explained how these showed that the Glacial epoch was not one long uninterrupted age of ice, but rather a succession of cold and mild periods. There was distinct evidence to prove that the great ice-sheet which buried Scotland to a depth of not less than three thousand feet, and which filled up all our shallow seas and even overflowed the outer Hebrides, sometimes melted away from our seas and low grounds and retired to the deep glens of the highlands, and then rivers flowed in our valleys and many lakes appeared, and the country was clothed and peopled with plants and animals. Similar phenomena were found to characterize the glacial deposits of Switzerland and America. The Scottish interglacial deposits had yielded remains of the mammoth, the Irish deer, the horse, the great ox, and smaller animals such as frogs and water-rats, and fragments of various kinds of trees, besides organisms peculiar to fresh-water. The Swiss accumulations contained beds of lignite with which were associated the great ox, the rhinoceros, the elephant, and other animals.

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[1] Being the substance of a Lecture delivered on 30th January, 1873, before the Birkenhead Literary and Scientific Society, Claughton Road, Birkenhead.

In America ancient forests were found lying between glacial deposits, the trees being still indigenous to that country, and remains of the old pachyderms had been met with in a similar position. In Scandinavia there was evidence to show that the glacial epoch was interrupted by at least two mild interglacial periods. The evidence derived from all these regions also clearly proved that since the last cold period of the glacial epoch there had been no warm or genial conditions, but only a gradual amelioration of climate down to the present time. The lecturer then went on to point out what bearing these facts had upon the question of man's antiquity in Britain. The evidence furnished by the palæolithic deposits showed that during their accumulation man experienced two kinds of climate, one of which was cold and almost arctic in character, the other mild and genial. Now, as no mild or genial climate had supervened in

Britain since the close of the Glacial epoch, it was clear that the hippopotami and elephants and other southern mammalia associated with palæolithic implements could not belong to Postglacial times: they must be either of Interglacial or Preglacial age. This conclusion received very strong support from the peculiar manner in which the implement-bearing gravels were distributed. These were confined solely to the south of England. None occurred in the north of England, in Scotland, in Ireland, in Scandinavia, or in Switzerland. In Scotland and in Switzerland we did get remains of the animals which were contemporaneous with the men of the old stone period, but these remains were all of Interglacial age. The same was the case in North America. If we took a map of the northern hemisphere, and coloured upon it all the ground covered with the deposits that were laid down during the last cold period of the Glacial epoch, we should find that none of the old pachyderms (hippopotami, elephants, etc.) and no flint implements were ever met with at the surface within that area. We should, indeed, get the old mammalia, but only in Preglacial and Interglacial deposits. But immediately beyond the limits of the coloured area we should observe that in Europe all the valleys (as in the south of England and in France) were more or less filled with vast deposits of river gravels, which contain abundant remains of the old pachyderms, and immense numbers of flint instruments. And it was well known that in America the great bone deposits, so abundant in the Mississippi valley and elsewhere, ceased to appear whenever the limits of the northern drift were approached from the south. These facts, he thought, could only be explained in one way—namely, by admitting that palæolithic man and his congeners belonged to interglacial times and in all probability to Preglacial times also. The absence of palæolithic deposits from the regions referred to was thus explained in a simple and reasonable way. The great confluent glaciers had ploughed out these deposits, and what portion the glaciers had spared had been subsequently covered up by marine accumulations during the last great submergence. But in those regions which the glaciers had not reached, and which were never submerged, the palæolithic gravels still existed in great force. Mr. Geikie then gave some account of Mr. Croll's theory, which explains the cause of great cosmical changes of climate, and showed how admirably Mr. Croll's conclusions tallied with the general results obtained from a study of the glacial deposits. The date given by Mr. Croll for the beginning of the glacial epoch was about 240,000 years ago; and this epoch, with all its alternations of cold and warm periods, lasted for about 1,600 centuries. Many most competent judges inclined to believe that man was of Preglacial age, which would give him an antiquity in Britain of more than 200,000 years. It was certain, at all events, that the animals with which palæolithic man was associated did live in Preglacial and during Interglacial times. This, of course, did not prove that man was of preglacial age; but since his implements were found at the very bottom of our cave deposits and old river gravels, it was highly probable that he

ered our country as early at least as the elephant and hippopota-
s; and the southern mammalia, as he had shown, could not have
ed in Britain in Postglacial times. Seeing, therefore, that man
s undoubtedly contemporaneous with these animals, we could not
ist the conclusion that he dated back to interglacial ages. It
ld not, indeed, be demonstrated that he occupied our caves during
earlier warm periods of the glacial epoch, but the evidence was
isive as to his presence in Britain during the last mild Interglacial
. And such being the case, he must have been the witness of
eral grand geological revolutions. During the last interglacial
iod he entered Britain at a time when our country was joined to
rope; at a time when our winters were still severe enough to
eze over the rivers in the south of England; at a time when
ciers nestled in our mountain valleys. He lived here long enough
vitness a complete change of climate—to see the arctic mammalia
ish from England and the hippopotamus and its congeners take
ir place. At a later date, and while a mild climate still continued,
beheld the sea slowly gain upon the land, until, little by little,
whole country was submerged as far south as the valley of the
ames—a submergence which reached in Wales and Scotland to
extent of 2,000 feet or thereby. At the same time a great de-
ssion drowned all the low grounds of Northern Europe. When
s depression had reached or nearly reached a climax, the last
cial period began. Intense arctic cold converted the few islets
ich then represented Britain into a frozen archipelago. From the
-foot that clogged the shores fleets of rafts set sail, and as they
rneyed on dropt angular blocks over the bottom of the sea. And
ere was palæolithic man at this time? Perhaps in the south of
rope, but surely not in England. Mr. Geikie then described the
er changes, and showed how upon the re-elevation of the land
itain was again joined to the continent. It was during this last
ntinental condition of our island that neolithic man and the
imals with which he was associated made their appearance. Pa-
olithic man and the southern mammalia had, as far as Britain was
ncerned, vanished for ever. This was the explanation he gave
the great break that separated the new stone age from the old
ne age. The one age was marked off from the other by a vast
se of time—by a time sufficient for the submergence and re-
vation of a large part of Northern Europe, and a great change of
mate.—*Liverpool Daily Albion*, February 1st, 1873.

III.—SHORT NOTICES.

1.—ACADEMY OF NATURAL SCIENCES, PHILADELPHIA.

AT a meeting of the Academy of Natural Sciences, Philadelphia,
rof. Cope exhibited the cranium of the horned Proboscidian of
'yom ng *Loxolophodon cornutus*, and made some remarks on its
finities. The short-footed Ungulates or *Proboscidia* are represented
two very different families in the Eocene formations of North

America, the ***Eobasiliidæ*** and ***Bathmodontidæ***. The first embraces four known genera, as follows:—

1. Nasal bones with flat horizontal horn-cores overhanging their apex.
Cervical vertebræ short; malar bone much reduced in front. ***Loxolophodon***, Cope.
2. Nasal bones with small tuberosities.
Cervical vertebræ short. ***Eobasileus***, Cope.
Cervical vertebræ longer; the malar bone reaching maxillary face. ***Uintatherium***, Leidy.
3. Nasal bones with produced, cylindric horn-cores.
Cervicals? ***Megaceratops***, Leidy.

Of the above genera there are five well-determined species, viz.: *L. cornutus*, Cope; *E. pressicornis*, Cope; *U. robustum*, Leidy; *U. lacustre*, Marsh; and *M. coloradoensis*, Leidy. *E. furcatus*, Cope, and *U. mirabile*, Marsh, would, perhaps, have to be added.

There are two genera of *Bathmodontidæ*, as follows:—

One posterior molar with two transverse crests. ***Bathmodon***, Cope.
Three posterior cross-crested molars. ***Metalophodon***, Cope.

Of this family 4 species are known, viz. *Bathmodon radians*, Cope; *B. semicinctus*, Cope; *B. brevipes*, Cope; *Metalophodon armatus*, Cope;

Philadelphia, February 28th, 1873.

2.—MEMOIRS OF THE GEOLOGICAL SURVEY OF INDIA.

In the Memoirs of the Geological Survey of India, vol. viii., pt. 2, Mr. Hughes has again contributed to the literature on the Coal-fields of India. Extending his labours to the West of the Damúdá Valley, he has mapped and reported upon two separate areas of Coal-bearing rocks, which have received the official titles of the Itkhúri, and Daltonganj Coal-fields. The importance of the Itkhúri basin is small, and there appears little chance of its ever becoming more than a local source of supply for the coarser necessities of engineering requirements.

The Daltonganj basin, on the other hand, seems destined—owing to its proximity to the Son (Sone) and to the canal works in connexion with that river—to occupy a much more active sphere in the economic history of India.

Politically this field—notwithstanding the inferior quality of its coals—may in the future be of high value: for during the great mutiny of 1857 it supplied some coal to the steamers engaged in transporting our troops from Bengal to the more disturbed districts of the North West; and should a like disaster again occur, its resources may be once more called into requisition for the purposes of quelling insurrection. We trust that these Memoirs are only the prelude to some general work on the Coal-fields of India. Already that country has, through the labours of Dr. Oldham and his able staff of Assistants, been rescued to some extent from the obscurity in which it was shrouded; and we trust that these separate contributions to the Memoirs of the Survey will before long be embodied in such form as best appeals to those interested in the industrial welfare of our Colonies.

REVIEWS.

A SKETCH OF THE GEOLOGY OF DERBYSHIRE. By the Rev. J MAGENS MELLO, M.A., F.G.S. 8vo. pp. 40. (London: Bemrose & Sons.)

THIS little Memoir, which was originally read before the members of the Chesterfield and Derbyshire Institute of Engineers, is published in a separate form, and as such will be found very useful, not only to the geologist, but also to those tourists who visit the picturesque Mountain Limestone dales which render Derbyshire so attractive, and who may wish to inquire into their origin, and that of the different rocks they meet with in their walks. The author treats his subject in an easy and interesting manner, and at the same time he has brought together as many of the principal facts relating to it as could be condensed into so small a compass.

He treats briefly of the peat-bogs so common in our moorland districts, which cover a vast extent of the Millstone-grit and Yoredale formations of Derbyshire, and which those who wander up the Kinderscout are likely to remember. The numerous springs which issue from the Mountain Limestone, and the tufa they frequently deposit; the alluvial deposits of the Trent and Derwent; and the glacial deposits, which occur chiefly in the southern part of the county, are also touched upon.

The Keuper marls and sandstones occupy the larger part of South Derbyshire; gypsum occurs abundantly in the marls, and rock-salt but sparingly, as indicated by slightly brackish water at Branstone; though its former presence is proved in other places by numerous pseudomorphous crystals.

Beneath the Keuper beds come the Bunter sandstones and Conglomerates, upon the middle member of which the Keuper beds are said to rest unconformably.

The Permian beds are then treated of; they include the Magnesian Limestone, which is so largely quarried for building purposes, especially at Mansfield, and the marls and sandstone which underlie it. These lower beds contain fossils apparently identical with those of the Coal-measures species of *Lepidodendron*, *Sigillaria*, and *Calamites*, which would seem to connect them more closely to the Carboniferous period, although not more conformable to its strata, than to the marine beds of the Permian.

Next we come to the account of the Coal-measures, Millstone-grit, Yoredale Rocks, and Mountain Limestone.

The latter rock furnishes some of the most beautiful scenery, and is very interesting on account of the great intrusive beds of Trap or Toadstone, which in places are at least 200 feet thick. The caverns for which the Limestone district is so noted are briefly alluded to by Mr. Mello; and in speaking of the dales, he remarks that they "were, probably, in many instances, originally caverns, which have been, through countless ages, eaten away by the streams, till at length the roofs have fallen in, and in their turn have been, for the most part, carried away by the same powerful agent." This explanation of the formation of certain valleys was given a few years ago by Prof. Phillips,[1] and also by Mr. Boyd Dawkins, to account for the origin of the Chedder Cliffs, in Somersetshire, and is certainly more plausible than that of Mr. Mackintosh, which would give them a marine origin.

Mr. Mello gives a list of the minerals found in Derbyshire, and accompanies his little work with a geological map and sections reduced from the publications of the Geological Survey. Four plates illustrate some of the characteristic fossils of the New Red Sandstone, Permian rocks, Coal-measures, and Mountain Limestone. H. B. W.

REPORTS AND PROCEEDINGS.

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GEOLOGICAL SOCIETY OF LONDON.—I. ANNUAL GENERAL MEETING.[2]—February 21st, 1873.—His Grace the Duke of Argyll, K.T., F.R.S., President in the Chair. The Secretary read the Reports of the Council, and of the Library and Museum Committee. The general position of the Society was described as satisfactory, and the number of Fellows was said to have essentially increased.

In presenting the Wollaston Gold Medal to Sir Philip de Malpas Grey-Egerton, Bart., F.R.S., F.G.S., the President spoke as follows:—

Sir Philip Egerton,—I consider myself fortunate in being the organ of the Geological Society in presenting you with the Wollaston Medal, which has been awarded to you by the Council for the present year. The eminent services which you have rendered to geology during a period now extending over forty years have long been familiar to scientific men, and have given you more than a European reputation. These services have been so great and so universally recognized, that the only difficulty I now have is not in assigning grounds for the vote which I have the pleasure of announcing, but in explaining why it has been so long delayed. That delay has been occasioned, I believe, solely by the fact that you have yourself been so long an honoured member of the Council whose duty it is to consider the claims of geologists for the honours of this Society; and whatever influence you have had in that body has doubtless been exerted in favour of others to the exclusion of yourself. It is at least some compensation for the loss which the Council sustains in your absence that it is now able to accord a recognition which has long been due. The many papers which you have contributed to this Society from 1833 down to the present time are a sufficient indication of the wide range of your observations. But the special attention you have bestowed and the light you have thrown on the structure and affinities of fossil fishes and reptiles, have been of the highest value, and have formed in the aggregate a most important contribution to our knowledge of the history of organic life. I have the highest pleasure in now handing to you the Wollaston Medal.

Sir Philip Egerton, in reply, said:—

My Lord President,—I know not whether it is owing to the poverty of the English language or to my unskilfulness in the use of it, but I am quite at a loss for words adequate to express my appreciation of the great and unexpected honour conferred upon me by the award of the Wollaston Medal, and for appropriate terms to convey to your Grace my acknowledgments for the kind, but too flattering terms you have used in communicating the decision of the Council; and my embarrassment is increased by the consciousness that, in comparison with those illustrious names which already adorn the Wollaston roll, I am quite unworthy of this great distinction. I cannot presume to think that the humble contributions I have been enabled to make to geological knowledge (and indeed to but a limited branch of it) can have been weighed in the balance against the labours of many others on both sides of the Atlantic, whose lives have been devoted to geological research, but who have not yet attained the distinction awarded to me to-day. In comparison with these my claims are quite insignificant. I must therefore look elsewhere to discern the motive which has influenced the Council in selecting my name on the present occasion in preference to others whose scientific claims are far greater than my own, and I think I am right in assigning it to a desire on their part to recognize, encourage, and occasionally reward the labours of those who, although their lot in life has been cast in a sphere entailing many paramount duties which ought not to be neglected, nevertheless devote their leisure time to the promotion of scientific research rather than waste it in frivolous and unproductive amusements. In this sense I interpret the mind of the Council in awarding me this Medal, and in this sense, as also as a stimulus and incentive to persevere in the cause of that science in which I take so deep an interest, and from the study of which I have derived so much intellectual enjoyment, I can, without arrogance, most gratefully accept it. May I be permitted to add, that if anything could enhance the feelings of gratification I experience in receiving this, the *blue ribbon* of geology, it is that it is presented by a President who, although occupying the highest social rank, and called by our gracious Sovereign to fill the highest offices of State, entailing most onerous duties and grave responsibilities, has nevertheless devoted himself to the study of scientific problems, and has inscribed for himself a name on the tablets of scientific literature, indelible so long as the Reign of Law shall continue to exist.

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[1] See GEOL. MAG. 1864, Vol. I., p. 229.

[2] A brief notice of this meeting appeared in the March Number, p. 132.

The President then presented the balance of the proceeds of the Wollaston Donation-Fund to J. W. Judd, Esq., F.G.S., and addressed him as follows:—

Mr. Judd,—I have much pleasure in delivering to you the award of the Council of this Society in recognition of your valuable researches in the Neocomian and Jurassic rocks of England, researches which you are now extending with such marked success to the Secondary and Palæozoic rocks of Scotland. I rejoice to know that you are to carry to an investigation of the West coast of Scotland the experience and knowledge you have shown in your recent account of the Secondary rocks of the East coast. The scattered and broken remains of the Oolites in the Hebrides constitute a most interesting field of investigation; and a detailed examination of them conducted by you cannot fail to cast important light on many geological problems of the highest interest to our science.

Mr. Judd made the following reply:—

My Lord President,—The recollection of an occasion like the present may well be cherished by a student of science as an incentive to exertion second only to the enthusiasm of research itself. Having learned to look to this Society, and never in vain, for the encouragement of sympathy and the guidance of criticism, it is with especial gratification that I receive this mark of confidence at the hands of my teachers and fellow-workers. When I think of the origin and traditions of this bequest—the objects contemplated by its illustrious founder, the distinguished geologists who have been its former recipients, and the important researches to which it has been made contributory—I am deeply impressed by the trust which you have reposed in me. It is my hope that by earnest labour I may be able to testify that my feelings of gratitude are not evanescent, nor my sense of responsibility light, in connexion with the great honour which you have this day done me.

The President then presented the Murchison Medal to Mr. William Davies, of the British Museum, and addressed him as follows:—

Mr. Davies,—I have much pleasure in delivering to you the Murchison Medal, which has been awarded to you by the Council of this Society in recognition of the services you have rendered to Palæontology in the arrangement of the vertebrate collections in the Geological Department of the British Museum, so as to render them available for the purpose of scientific study, in the skill and knowledge you have displayed in the reconstruction of extinct forms of life. I have the more pleasure in giving this Medal, as I believe you will have the greater pleasure in receiving it, from the fact that it is the first award made under and in fulfilment of the will of the great geologist and excellent man whose loss we have all had so lately to deplore. I trust it may long serve to stimulate others to such services as you have rendered, and which have appeared to the Council of this Society to make you a worthy recipient of the First Murchison Medal.

Mr. Davies, in reply, said:—

My Lord Duke,—I desire to return my most sincere thanks to your Grace as President, and to the Council of this Society, for the honour they have conferred upon me in awarding me the Murchison Medal. It is extremely gratifying to find that the humble services I have rendered to Palæontological science have been so kindly appreciated and deemed worthy of this high recognition. The pleasure is greatly enhanced by the fact that I have never considered my scientific work of sufficient importance to deserve any recognition—the acquisition of scientific knowledge and the happiness of communicating it to others having, in my own case, been its own reward. I shall now feel it to be my duty as well as my ambition to render myself more worthy of the distinction you have this day conferred upon me—one which has also an especial significance to a servant of that great National Institution for which Sir Roderick Murchison so long and beneficially acted as a Trustee.

The President then delivered to Prof. Ansted, F.R.S., For. Sec., for transmission to Prof. Oswald Heer, of Zürich, the balance of the Murchison Fund, and spoke as follows:—

Mr. Secretary,—The labours of Prof. Heer in Fossil Botany and Entomology have this year been recognized by this Council in the vote of the Murchison Fund. No branch of Palæontology requires more minute research, more careful comparison, more circumspect conclusions,—and there are none, I may add, which, when so conducted, are richer in suggestions on the history of geological change. The fragmentary character which generally belongs to terrestrial and especially to botanical remains, places the study of them under special difficulties, difficulties which have been met with special skill by Prof. Heer. The remains of the Miocene flora are connected with some of the most perplexing problems of our science, and the light which has been thrown upon them by Prof. Heer more than deserves the recognition which I have now the pleasure of delivering into your hands for transmission to that distinguished man. This is the second mark of recognition which this Society has given to Prof. Heer, the Wollaston Donation Fund having been voted to him in 1862.

Prof. Ansted having suggested that Sir Charles Lyell, as a particular friend of Prof. Heer's, might very appropriately speak in his name, Sir Charles Lyell, in reply, referred briefly to the nature of Prof. Heer's work, and said he was sure that gentleman would appreciate highly this renewed expression of the interest taken by the Geological Society in his pursuits. Sir Charles Lyell remarked, further, that he was particularly gratified that this award had been made at the present time, as Prof. Heer was well advanced in years and in an exceedingly infirm state of health, so that perhaps another opportunity of showing him respect and sympathy might not occur.

The President then proceeded to read his Anniversary Address, in which he discussed the phenomena of denudation, referring especially to the influence of subterranean and other movements of the crust of the earth upon the denudation of its surface, and disputing the greatness of the denuding effects of glacial action. The Address was prefaced by biographical notices of deceased Fellows, including Prof. Sedgwick, Dr. Kelaart, Mr. Augustus Smith, Mr. N. Beardmore, and Prof. Pictet.

The Ballot for the Council and Officers was taken, and the following were duly elected for the ensuing year:—*President:* The Duke of Argyll, K.T., D.C.L., F.R.S. *Vice-Presidents:* Prof. P. Martin Duncan, M.B., F.R.S.; R. A. C. Godwin-Austen. Esq., F.R.S.; Joseph Prestwich, Esq., F.R.S.; Prof. A. C. Ramsay, LL.D., F.R.S, *Secretaries:* John Evans, Esq., F.R.S.; David Forbes, Esq., F.R.S. *Foreign Secretary:* Warington W. Smyth, Esq., M.A., F.R.S. *Treasurer:* J. Gwyn Jeffreys, Esq., F.R.S. *Council:* Prof. D. T. Ansted, M.A., F.R.S.; The Duke of Argyll, K.T., D.C.L., F.R.S.; William Carruthers, Esq., F.R.S.; Prof. P. Martin Duncan, M.B., F.R.S.; Sir P. de M. G. Egerton, Bart., M.P., F.R.S.; R. Etheridge, Esq., F.R.S.; John Evans, Esq., F.R.S., F.S.A.; J. Wickham Flower, Esq.; David Forbes, Esq., F.R.S.; Capt. Douglas Galton, C.B., F.R.S.; R. A. C. Godwin-Austen, Esq., F.R.S.; J. Whitaker Hulke, Esq., F.R.S.; J. Gwyn Jeffreys, Esq., F.R.S.; Sir Charles Lyell, Bart., D.C.L., F.R.S.; C. J. A. Meyer, Esq.; J. Carrick Moore, Esq., M.A., F.R.S.; Joseph Prestwich, Esq., F.R.S.; Prof. A. C. Ramsay, LL.D., F.R.S.; R. H. Scott, Esq., M.A., F.R.S.; Warington W. Smyth, Esq., M.A., F.R.S.; Prof. J. Tennant, F.C.S.; W. Whitaker, Esq., B.A.; Rev. T. Wiltshire, M.A., F.L.S.

II.—February 26th, 1873.—Prof. Ramsay, F.R.S., Vice-President, in the Chair. —The following communications were read:—1. "On the Jurassic Rocks of Syke and Raasay." By James Bryce, M.A., LL.D., F.G.S.

In this paper the author described numerous sections of Jurassic rocks exposed chiefly in the sea-cliffs of Skye and Raasa, indicating the presence in those islands of a complete series of beds ascending from the Lower Lias to the middle of the Middle Oolite. He noticed the occurrence in these sections of fossils belonging to the zones of *Ammonites angulatus* and *A. Bucklandi* in the Lower Lias, to the zones of

A. Jamesoni, *A. capricornis*, *A. margaritatus*, and *A. spinatus* in the Middle Lias, of Upper Lias fossils, including *Ammonites communis*, *falcifer*, *heterophyllus*, and *bifrons*, and of others indicating beds belonging to the Inferior Oolite and Cornbrash, and to the Oxford Clay. The Loch Staffin beds were described as an estuarine series, nearly approaching the Oxford Clay in geological age, and including a bed almost entirely made up of the shells of *Ostrea hebridica*.

The whole series of Jurassic rocks in these islands reposes on the Torridon sandstone of Cambrian age; and the author discussed the question whether or not the intervening beds have ever existed in this locality, and came to the conclusion that they probably existed, and have been swept away by denudation. He remarked further upon the resemblance in lithological characters of the beds described with the corresponding deposits elsewhere in Britain. The trap-rocks intruded between the Jurassic deposits he regarded as of post-Oolitic date. The paper was accompanied by lists of fossils and descriptions of some new species prepared by Mr. Ralph Tate.

Discussion.—Mr. Judd pointed out that, contrary to the views of that school of geologists of whom Dr. Macculloch was the leader, and which regarded the geological investigation of Scotland as almost completed, that work was only now being commenced by the application of those principles of Palæontological geology which had been developed in England, and especially fostered by the Geological Society. He congratulated Dr. Bryce on having secured the aid of so experienced a palæontologist as Mr. Tate, and bore witness to the fidelity with which his sections, especially those of the Island of Skye, were described. He also pointed out the importance of this communication as completing the history of a series of sections first so well sketched by Murchison, and in parts described in detail by Geikie, Wright, and Edward Forbes.

2. "Observations on the more remarkable Boulders of the North-West of England and the Welsh Borders." By D. Mackintosh, Esq., F.G.S.

In this paper the author described the situation and indicated the probable origin of many of the more striking known boulders in Westmoreland, Cumberland, Lancashire, Cheshire, and on the borders of Wales. The northern boulders seem to have originated chiefly from Wastdale Crag, Criffel, Ennerdale, and Eskdale; those of Cheshire chiefly from the Lake District and South of Scotland; and many of those on the Welsh borders from the mountains of Wales. Many of the boulders noticed by the author exhibit glacial striæ. The author also especially referred to the occurrence of boulders at high levels.

Discussion.—Mr. Tiddeman pointed out that the course of a boulder from its original source to the spot where it was deposited was probably not always in a straight line; but the carrying agents were probably diverted by currents connected with the conformation of the sea-bottom of the period. In some cases also boulders may have had their position changed by subsequent river-action, and also by other means.

Mr. Hicks called attention to some of the boulders to be seen in the south of Wales, which have been striated by the action of the plough and the harrow, as well as by ice, the marks of which had been almost entirely obliterated by human agency.

Mr. Koch mentioned that in the late floods in Bohemia blocks as large as 6 feet × 4 feet had been transported by the rivers, and their surface had been striated during the process in a manner much like that produced by ice.

The Chairman pointed out that in some instances the transported blocks had travelled over country higher than the parent beds from which they had been derived, and considered that they afforded some support to the theory of a great and general ice-coating, which was immediately succeeded by a period of great depression below the sea-level, and a subsequent emergence, the whole comprised within one great glacial period. During these oscillations there must of necessity have been a series of dispersions of boulders.

Geologists' Association. — March 7th. — Henry Woodward, Esq., F.G.S., F.Z.S., President, in the Chair.—"On the Geology of Brighton." By James Howell, Esq.

The paper commenced with a sketch of the South Downs, their longitudinal valleys, latitudinal coombs, and the gaps leading down the cliffs which extend from Eastbourne to Brighton. The author enumerated those interesting outliers of the Plastic Clay lying between Seaford Heights and Felpham, the connecting links with the Bognor beds, showing that the Eocenes were once continuous along the southern portion of the Downs to the height of 600 feet, that is if the pebbles found on the crest of Cisbury are what they appear to be, of Tertiary origin. He considered there was no evidence from surface indications that the northern portion of the Downs has ever been submerged since its upheaval. Historical documents, submerged forests along the whole coast-line, and the shallowness of the sea-bottom afford evidence that the sea has greatly encroached upon the land at this part of the coast. The site of Old Brighton was stated to be seaward between East and West Streets, and not, as Lyell states, where the Chain Pier now stands. The coast-line at the period when the Brighton valley was an estuary of the sea and a river was very different from what it is now. The "Level" was then covered with water, and waves dashed up beyond the site of St. Peter's Church, as proved by pebbles like those on the present beach being there found in sewer excavations.

The geological formations at Brighton were stated to be six, viz. Silt in the valley, Brick-earth of Hove, the Elephant-bed, Temple Field deposit, Plastic Clay of Furze Hill, and the Upper Chalk. The present paper embraced the author's observations of the first three. In the lower portion of the Silt and the Coombe-rock beneath it are imbedded immense numbers of water-rolled sandstones similar to the Sarsen stones distributed over the surface of the Downs, but whether of Wealden or Tertiary origin is unknown. The Brick-earth is a later formation than the Elephant-bed, upon which it everywhere rests; though the organic remains found in it are the same, viz. remains of the elephant, horse, red-deer, whale, and shells of an arctic type. If, as Mr. Godwin-Austen tells us, Brick-earth is the "wash of a terrestrial surface," how are we to account for the marine remains imbedded in it? The pebbles of Palæozoic rocks found in the old sea-beach underlying the Elephant-bed were stated to have come from France, when that country was united to this island, having travelled a beach once extending from Brighton to Calvados. This was supported by the observation of the author of how pebbles travel along coasts assisted by sea-weed, whose roots are attached to them. In concluding his paper, Mr. Howell opposed the opinion formed by the Geological Section of the British Association during their visit to the Kemp Town section of the Elephant-bed, that this remarkable deposit was due to ice action, and considered the opinions of Webster, Mantell, and Lyell, corroborated by the fact that the materials composing the bed are all water-worn.

CORRESPONDENCE.

THE OLDEST KNOWN BRITISH TRIGONIA.

Sir,—The claim of *T. Lingonensis* to this title does not rest on the York specimen, but on several that have been found and recognized *in situ.* This is all the public can care to know; but as I identified the specimen in our Museum, you may allow me to add that it is not "an undoubted Inferior Oolite fossil." The Dogger of the Peak is very similar to the Eston Ironstone, in hand specimens; but any one familiar with both could easily distinguish them. Mr. Leckenby is probably not familiar with the latter—as there are few, if any, fossils from it in his magnificent Lias collection—unless he has them labelled from the Inferior Oolite. One is reminded of a remark long ago made by Williamson, that Yorkshire geology has suffered from the fossils being collected miscellaneously, and their horizon judged of by their matrix. J. F. Blake.

Clifton, York, *March 6th*, 1878.

DISCOVERY OF PREHISTORIC REMAINS IN INDIA.

(Extract of letter from R. Bruce Foote, Esq., F.G.S., of the Geological Survey of India.)

"You will be interested to hear of a prehistoric discovery lately made by a friend of mine (a Mr. Fraser, a civil engineer in Government employ) near Bellary, namely, of large numbers of celts, rubbing-stones, and pounders, under such circumstances as to leave no doubt that the hills in which they occur were occupied by the manufacturers, who have left numerous very considerable kitchen-middens behind them, resting on rude terraces constructed among the immense tors and blocks of granite gneiss of which the hills consist.

Their surface-inspection yielded large numbers of the implements and flakes innumerable; the middens themselves ought therefore to be extremely good hunting-ground when they come to be carefully excavated, as I trust they will before very long.

The celts are in all stages, from the rudest and most palæolithic chipped implement to the completely polished type. The majority are, I think, only polished in part, at the edge. Nearly all are made of Greenstone, which does not occur within several miles of one locality discovered by Mr. Fraser, but a large dyke of which traverses the other.

Of the rubbing-stones most are made of granitic rock, many of a variety totally different from that forming the hill-range.

The round pounding-stones are mostly made of Greenstone.

I had the good luck to discover a third settlement a few days after Mr. Fraser had shown me the two localities he had found. Mine is some 15 or 16 miles west of Bellary. It is a large conical mound, consisting chiefly of soft yellowish slag, in layers, interstratified with the midden-stuff, as shown by many little rain-sections. By-the-bye it has been described somewhere already as a volcanic ash-cone!

Being on the march, and the place a very long way from my next stage, I could only devote a very brief space of time to it, but, in a few minutes, I had obtained a polished celt, some pounders, and rubbing-stones, not to mention flakes. One pounder is made of very hard rich red hæmatite. The celt is of Greenstone; it has been burnt. The settlement was very likely burned down at several intervals—an occurrence not rare at the present day in poor villages, where the huts are very largely built of the coarse stiff straw of the *Holcus Sorghum*."

We hope to hear further particulars of this very interesting discovery from Mr. Bruce Foote.—Edit. Geol. Mag.

THE CYCLAS CLAY OF WEST LANCASHIRE.

Sir,—In your last Number, Mr. T. M. Reade denies the existence of a fresh-water clay underlying the peat of the West Lancashire lowland plain, and seems to be under the impression that I never recognized the existence of a Lower Scrobicularia Clay, occupying a similar position, until the appearance of his papers, and appears to suggest that I should adopt his names of "Washed-Drift Sand" and

"Formby and Leasowe Marine-beds" for the deposits below the peat, which it is impossible for me to do—firstly, because he includes the Middle Glacial Sand and Shingle with the *Post*-glacial Shirdley Hill Marine Sand, which I found to rest on thin seams of peat; secondly, because I consider his Marine-beds to be estuarine and lacustrine; and thirdly, because the names I proposed in 1869 for these beds have the priority of age, his paper appearing in 1872.

In my paper on the Post-glacial Deposits of Western Lancashire and Cheshire (Quart. Journ. Geol. Soc., 1870), in the Explanation of the Geological Survey Map 90 S.E., in 1870, in that of 90 N.E., 1872, and in the Explanation of the Geological Survey Horizontal Section, Sheet 63, I have described the following sequence of Drifts:

Post-Tertiary.	Recent	Blowing Sand, Blown Sand (Land-surface).	
		Upper "Cyclas" Clay.	Alluvium.
		Sand and Loam.	
		Upper "Scrobicularia Clay"—Tidal Alluvial Estuarine.	
	Pre-historic	Upper Peat, often 20 to 30 ft. in thickness (Land-surface).	
		Lower Cyclas Clay (Lacustrine).	
		Lower "Scrobicularia Clay" (Tidal).	
Newer Pliocene.	Post-glacial	Shirdley Hill Sand, Presall Shingle (Marine).	
		Lower Peat (Land Surface).	
	Glacial	Upper Boulder Clay (Marine).	
		Middle Sand and Shingle (Marine).	
		Lower Boulder Clay (Marine).	
		Till (Land-surface).	

In 1868, after reading Mr. Morton's description of the thick peat beds resting on *Scrobicularia* Clays, exposed on the coast of Wirral, near Leasowe, I visited that district, and correlated his *Scrobicularia* Clay with a like clay occurring at Eccles Place, near Crossens, in the estuary of the Ribble, the overlying thick peat being nearly continuous between the two points. Finding another clay with *Scrobicularia* in the alluvium of the Alt, of later date than the peat, I described it in the "Explanation of the Geological Survey Map 90 S.E.," as the "Upper Scrobicularia Clay," in contradistinction to the *Lower* Scrobicularia Clay of Wirral and Crossens, which latter deposit, though recognized to the north and south of the area comprised in that Map, I failed to find in that area, after a most careful examination of all the grey clays thrown out, in cutting the long dykes and sluices so characteristic of that country. Here and there, at isolated points, as immediately east of Freshfield and Ainsdale, in the experimental brick pit made near the "Isle of Wight," Birkdale, I found shells of *Cyclas cornea,* fragments of horns of red deer, and thin seams of peat.

I therefore am convinced that the *larger portion* of these clays in Lancashire, but *not* in Cheshire, or in North Wales, are of freshwater origin. But at the same time, from their gradual thinning out eastward upon marine Shirdley Hill Sand,[1] from the intercalation of the "Tellina Balthica Sand," in the main peat of Crossens and Leasowe, and from the similar intercalation of peat in the grey clays

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[1] As shown in Hor. Sec. of the Geol. Sur., Sheet 63, and described in its Explanation, and in the Exp. of Geol. Sur. Map 90 S.E., 1870.—C. E. De R.

(which I observed in December last, in the excavation for gas-works) at Blowick, near Southport, one would expect varying and alternating conditions, and contemporaneous "Lower Scrobicularia Clay" to alternate, or even entirely take the place of the Lower Cyclas Clay, in any local area.

The following remarks occur in my paper on the "Post-Glacial Deposits," etc. (describing the Leasowe Clays):—"Whilst this deposition went on, freshwater forms might have lived in pools of fresh water in hollows of the Boulder-clay, simultaneously with marine in other pools, filled by high tides a few feet distant;—fluviatile and marine forms of life preponderating horizontally and vertically in the silts, according to whether freshets or spring tides happened to be in the ascendent. This state of things is going on at the present time, in the marshes of the Ribble, between Preston and Southport, where, after heavy rains or floods, freshwater shells may be found, during neap tides, in the hollows of the (recent) Scrobicularia mud, and where crabs may be found living in all the ditches for one or two miles inland."

At the close of the Glacial epoch, several alternations of level appear to have taken place; the surface of the Upper Boulder-clay, beneath the Shirdley Hill Sand, is coated with a thin seam of peat, at a little above the present high-water level, formed after much denudation of Boulder-clays in the lowlands had taken place. Over this denuded plain of Boulder-clay the Sands were deposited, and blown from its edges into a line of ancient dunes, equivalents in time of the Presall shingle-beds (Quart. Journ. Geol. Soc., 1870, p. 461), and the Rampside beds described by Miss Hodgson of Ulverstone.

This sea-bottom becoming land, gradually increasing in extent, streams cut channels in the sands, and carried their débris westwards, into the hollows, and swamp basins, in the Boulder-clay, and deposited the Cyclas Clay, which graduates westwards, along a line not exactly corresponding to the present sea-coast, into the Lower Scrobicularia Clay.

Elevation continuing with obstruction of drainage, peat was formed, under continental conditions, which conditions are now being succeeded by a subsidence still in progress.

In the Blowick Clay, a skull and several antlers of Red Deer have been recently discovered at a depth of 16 feet from the surface. One of the latter, procured by my friend the Rev. John Bone, of Southport, has been presented by him to the Museum of Practical Geology, Jermyn Street.

I am glad to see that my suggestion to Mr. Reade, of examining the Grey Clays for *Diatomaceæ*, has been productive of good results.

Geological Survey Office,
Jermyn Street, S.W.

C. E. De Rance.

HUNSTANTON "RED CHALK."

Sir,—Allow me to call your attention to the subjoined extracts from the Survey Catalogue of Rock Specimens apropos of the paragraph on Hunstanton Red Limestone, by W. S. M., at p. 114 of the

GEOLOGICAL MAGAZINE for March, from which it will be seen that Edward Forbes has certainly the priority. H. W. BRISTOW.

Catalogue of Rock Specimens. Second Edition, 1859.

P. 86. No. 102. *Earthy Limestone*, the equivalent, probably, of Upper Greensand. Hunstanton, Norfolk.

No. 103. *Red Chalk*, *Earthy Red Limestone*, probably equivalent to the Gault. Hunstanton, Norfolk.

Catalogue of Rock Specimens, p. 157. Third Edition, 1862.

98. *Red Earthy Limestone*, Upper Greensand. Hunstanton, Norfolk.

The Red Chalk of Hunstanton, as it is sometimes called, has been referred, by different authors, indifferently, to the Gault, Upper Greensand, and Chalk. Its proper position in the geological scale, is, most probably, that which has been assigned to it by Sir Roderick Murchison, who, in 1836, stated it to be the equivalent of the Upper Greensand. The truth of this is corroborated not only by its lying immediately beneath the Chalk, which rests conformably upon it, but by the evidence of its fossils, the preponderance of those peculiar to each of the three formations being in favour of the Lower Greensand.

Its red colour is attributed to the peroxidation of the green grains of silicate of iron (or glauconite) with which it is charged. By the late Professor Edward Forbes, the Red Chalk was considered to be the equivalent of the Gault.

99. *Earthy Limestone*. Hunstanton, Norfolk.

This deposit was considered by the late Professor Edward Forbes to be, in all probability, the equivalent of the Upper Greensand of the south of England.

MUSEUM OF PRACTICAL GEOLOGY,
JERMYN ST., S.W.

MISCELLANEOUS.

MR. E. RAY LANKESTER ON *SCAPHASPIS* AND *PTERASPIS*.

IN connexion with Magister Schmidt's Note on *Pteraspis Kneri* (see antè, p. 152), we subjoin the following copy of a letter from Mr. Ray Lankester, published in the *Academy* for January 1st, 1873, p. 11, which may serve to show that author's views on the supposed connexion between *Scaphaspis* and *Pteraspis*, and also to refute the late Dr. Künth's theory of the connexion of these anomalous Fishes with the Crustacea.—EDIT. GEOL. MAG.

"In the Notes of Scientific Work of the *Academy* of November 1 (vol. iii., p. 412) there is an abstract of a paper by Dr. A. Künth on *Pteraspis*, in which evidence is brought forward to establish a view as to the nature of the organisms included under that term, contrary to that which I (confirming by more extended study the views of Agassiz, Salter, and Huxley) have put forward in my Monograph of the *Cephalaspidæ*, published by the Palæontographical Society. It is to me a cause of twofold regret that Dr. Künth has perished in the Franco-Prussian war, for not only have we thus lost a chance of obtaining additional knowledge of the Berlin *Cyathaspis*, but I shall be unable to obtain from him the admission that his conclusion is not in accordance with the facts. Nevertheless, I am bound to point out how valueless is the evidence of Crustacean affinities for *Cyathaspis* adduced by him, and how firmly, on the other hand, it is established that the *Heterostraci*—or genera *Pteraspis*, *Cyathaspis*, *Scaphaspis*—are the remains of fish. 1st. The minute structure of these shields or cephalic plates is a very peculiar one, having a striated, a cancellous, and a laminate stratum. In the three genera it is beyond all doubt established that the structure is identical, as Dr. Künth admits. The same kind of origin must be assigned to the plates of all three genera. Hence, if *Pteraspis* be the remains of a fish, so are *Cyathaspis* and *Scaphaspis*. This position, I believe, is unassailable, and was admitted by Dr. Künth. 2nd. A specimen, most carefully figured and described in my Monograph, now in my possession, but which I shall shortly place in the British Museum, shows seven rows of rhomboid scales attached (not merely adjacent to) to a portion of the head-shield of a *Pteraspis*. That these are true scales or lozenges of sculptured calcareous matter is *absolutely certain*: it is also *absolutely certain* that the shield is Pteraspidian, and that the scales and shield belong to the same individual organism. This is clear from the figures drawn by Mr. Fielding, and cannot be doubted without charging both him and me with gross misrepresentation. 3rd. The scales are fish-like. I know of no Arthropod, nor any other organism except a Fish, which possesses any structure even remotely representing them. The shells of *Chitonidæ* and *Cirrhipedia* are the only animal structures, except the scales of a Ganoid fish (with which they agree exactly), which they could even vaguely suggest. Hence the *Pteraspis* shield was borne by an organism which bore also scales like those of a fish: that is, a fish or fish-like animal. And what is true of *Pteraspis* is from paragraph 1 shown to be true of *Scaphaspis* and *Cyathaspis*. 4th. In figs. 8, 9 of pl. vii. of my Monograph, restorations of the form of the shield of *Pteraspis* are given, which are not hypothetical or schematic, but simple copies of the parts preserved in various specimens, some nearly perfect, also figured in the work. The form of his shield, and its details as to apertures, processes, etc., agrees with the view that it belongs to a fish most fully. It has not the remotest suggestion of Crustacean affinities about it. Hence again, and by quite independent evidence, we have the piscine nature of *Pteraspis* indicated. Hence by paragraph 1 we have also additional warrant for considering *Cyathaspis* to be piscine.

Turning now to Dr. Künth's material, consisting of shields undeniably referable to my *Scaphaspis* and *Cyathaspis*, I find—if I may judge from his by no means carefully finished drawings—nothing which can be seriously put in the balance against the above incontestable demonstration of fish-like characters. If Dr. Künth's evidence did warrant his inferences as to Crustacean affinities, it could not affect the facts cited above. We should have to regard the Pteraspidians as organisms combining the characters of Fish and of Crustacea. But the evidence offered is really ludicrously insufficient. These shields occur often enough, crowded together in a slab of stone. Dr. Künth picks out two shields, accidentally brought into contact with certain most vague and irregular fragments placed near them—not by any means attached to them—and upon these raises a theory. The specimen, if we may judge by the figure, cannot really cause a moment's serious doubt in the mind of any person acquainted with the character of those figured in my Monograph.

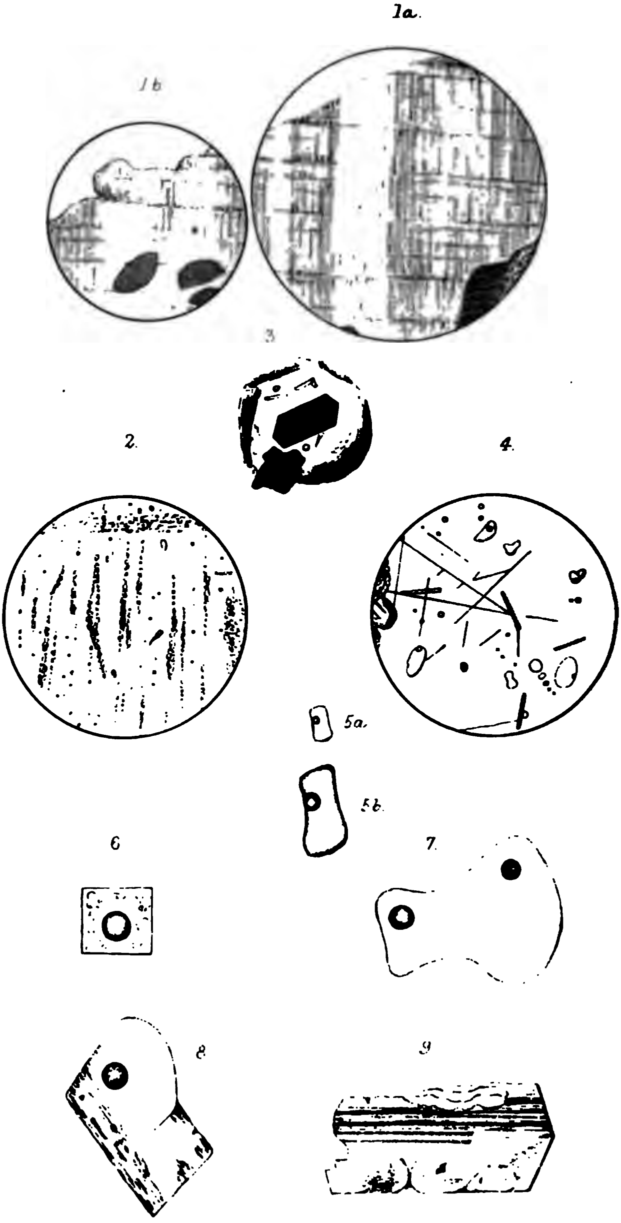
Whilst there is simply no scope for discussion upon the question of Crustacean affinities raised by Dr. Künth, the possibility of the organic association in the same individual of the shields which I have assigned to the genera *Scaphaspis* with those assigned to *Cyathaspis*, and in other individuals with those assigned to *Pteraspis*, is altogether another matter. I myself carefully suggested this possibility, and mentioned the association of some of the forms, which suggestions Dr. Künth quotes from me. I do not think Dr. Künth's specimen bears any characters which should modify my view of the matter. There is nothing which leads to the notion that the two shields he figures were organically connected; and I have—dealing with an enormously larger body of material—pointed out in my Monograph a number of facts which have led to an opposite conclusion.

A few months since I received from Herefordshire a specimen of a Heterostracous shield, which is new, and is distinctly intermediate between *Pteraspis* and *Scaphaspis*. This I hope soon to figure and describe in the GEOLOGICAL MAGAZINE. The rostrum is well developed, but is not distinctly marked off from the rest of the shield as in *Pteraspis*, nor are the cornual regions and apertures developed. This new specimen furnishes a timely support to the view that in *Scaphaspis* we have the same essential parts as in *Pteraspis* reduced or rather undeveloped. (Signed) E. RAY LANKESTER."

EXETER COLLEGE, OXFORD.

PALÆONTOGRAPHICAL SOCIETY.—The Annual General Meeting of this Society will be held in the Apartments of the Geological Society, Somerset House, on Friday, 4th April, at 5 o'clock P.M. The twenty-sixth Annual Volume, for 1872, appeared in October last, and contained: 1. Supplement to the Fossil Corals, part iii., Oolitic, by Prof. Martin Duncan, M.B. Lond., F.R.S., V.P.G.S., 7 plates, with indexes to Tertiary and Secondary Corals, pp. 42. 2. Cretaceous Echinodermata, vol. i., part v., by Thomas Wright, M.D., F.R.S.E., F.G.S., 5 plates, pp. 24. 3. British Fossil Crustacea: Order Merostomata, part iv., by Henry Woodward, F.G.S., F.Z.S., 10 plates, pp. 60. 4. British Fossil Trigoniæ, by John Lycett, L.R.C.P.E., No. 1, 9 plates, pp. 52. The Honorary Secretary, the Rev. Thomas Wiltshire, M.A., announces that volume xxvii., for the present year, is in a forward state of progress. Very many of the sheets are in type, and the majority of the plates printed. This volume will comprise:—

1. Cretaceous Echinodermata, part vi., by Dr. Wright.
2. Carboniferous Entomostraca, by Prof. Rupert Jones and Mr. J. W. Kirkby.
3. Fossil Merostomata, part v., by Mr. H. Woodward.
4. Crag Supplement, part ii., by Mr. Searles Wood.
5. Fossil Trigoniæ, No. 2, by Dr. Lycett.
6. Wealden Reptilia (*Iguanodon*), Supplement No. 5, by Prof. Owen.
7. Pleistocene Mammalia, part vi., by Mr. Boyd Dawkins.
8. Brachiopoda, Supplement, part i., by Mr. Thomas Davidson.



Mintern Bros imp

To illustrate Prof. Hull's paper on the Microscopic structure of Irish Granites

THE
GEOLOGICAL MAGAZINE.

No. CVII.—MAY, 1873.

ORIGINAL ARTICLES

I.—OBSERVATIONS ON THE MICROSCOPIC STRUCTURE OF IRISH GRANITES. (No. 1.)

By Professor EDWARD HULL, M.A., F.R.S.

(PLATE IX.)

[Read before the Royal Geological Society of Ireland, 9th April, 1873.]

Granite of Firbogh. Galway Bay.—I propose, as time and opportunity permit, to give the results of observations on the microscopic structure of Irish Granites, commencing with one from Galway.

This is a porphyritic granite from the great tract of granitic rocks which stretches westward from the town of Galway itself. It consists of a base of silica, dull waxy felspar, and dark-green mica in nearly equal proportions, in which are embedded pink or flesh-coloured crystals of orthoclase. These last are sometimes half an inch in length, and though generally occurring as individuals, are often present as twins. The granite is foliated, and probably of metamorphic origin.

Silica.—Silica occurs without crystalline form enveloping all the other minerals. It is structureless, but full of cells which are visible with a high power. With polarized light, and on rotating the upper prism, the silica presents the usual gorgeous play of colours; being broken up into distinct patches of irregular form, each refracting different prismatic colours. Some of the patches show round their edges parallel wavy bands of prismatic colours, marking out the individuality of the patches, and indicating the manner in which the particles consolidated in independent masses of various sizes—sometimes exceedingly small. The cellular structure of a portion of the silica is shown in Fig. 4. These cells are often so minute that three successive series are brought into the field upon changing the focus of the microscope by means of the mill-headed screw, with a magnifying power of 350 diams. Along with the cells are numerous long "belonites," or "trichites," sometimes perfectly straight, and stretching in all directions through the mass of the silica. With the 1-inch object-glass these can be generally observed, but with the ¼-inch and the No. 2 eye-piece, magnifying 350 diams., they are very well brought out, sometimes in extraordinary numbers. Even with this power their apparent thickness is not so great as that of the finest needle, with an apparent length from an inch downwards. In one or two instances they appear to be barbed, but this may be owing to the meeting of two trichites at a point: there are also examples of trichites slightly bent or curved. The general appearance of these in one part of the field is represented in Fig. 4. Sometimes the silica contains cells only without trichites.[1] What the nature of these needle-like objects may be I have no means of judging from this slice.

Cavities are exceedingly numerous in the silica. Some of these resemble the forms described and figured by Mr. Sorby in his admirable and well-known paper "On the Microscopical Structure of Crystals."[2] They are of various shapes, inclosing the little globule of fluid which just comes into view with a magnifying power of 350 diameters; and must be less than $\frac{1}{1000}$ of an inch in diameter. Others, however, are much larger, and sometimes do not appear to contain any bubble; and, as Mr. Sorby suggests, the fluid may have escaped. One of the fluid cavities is represented in Fig. 5, others in Fig. 4.

Stone cavities, or appearances which I take to be such as figured and described by Mr. Sorby, are also numerous in the silica. Along with the confused broken materials which they contain are also minute black specks. The form of these stone cavities is often very irregular and ill defined.

Occasionally perfect spheres occur, which may be assumed to be gas cavities. They are, however, rare; but one I have attempted to represent (Fig. 6) is associated with several others, and is of the apparent size represented, when magnified about 1000 diams. Figures 7 and 8 are similar spheres in the silica of a reddish porphyry from the Old Red Sandstone of Lesmahago, which are inserted for the sake of comparison. They are exceedingly beautiful objects under the microscope, the opaque walls shading off into the translucent centres through a series of delicately blended purple rings.

Felspar (Triclinic).—The dull waxy-looking felspar of the base is triclinic, and in all probability oligoclase. With polarized light the parallel-banded structure characteristic of triclinic felspars is apparent in the case of several small crystalline grains (see Fig. 9), but the bands of colour are less vivid than in the case of some albite felspars. I hope on a future occasion to compare the relative refractive powers of albite and oligoclase in granite.

Orthoclase.—This felspar predominates, not only in the larger individual flesh-coloured crystals, porphyritically developed, but in the base itself. In the case of the larger crystals, however, it presents a very remarkable appearance, especially when seen by polarized light, showing a *cross-banded* structure of a kind very dissimilar from the banded structure of the triclinic felspars (Fig. 1.) This structure I have observed in thin sections of granite from other districts, such as Dublin and Wicklow; but not in the felspar of any other rock but granite; and my present impression is that the cross-banded structure is characteristic of granitic rocks. Dr. Zirkel has, I believe, observed a similar structure.

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[1] I am uncertain whether to use the term "belonites," "trichites," or "nadelchen"—terms used by Zirkel and Allport for somewhat similar objects in the base of some basalts. Apparently similar hair-like bodies from the "sanidinite" of Mont Dore are considered by Dr. A. v. Lasaulx to be hornblende. Poggen. Annalen B. 144, p. 156.

[2] Quart. Journ. Geol. Soc., Lond., vol. xiv. p. 453.

This structure differs from that of the triclinic felspars, in that the bands of colour are somewhat irregular, interrupted, and crossed by other bands perpendicular, or nearly so, to the former. On rotating the analyzer, the colours change through purple shading into yellow; grey, and blue shading into green. At first I was in doubt regarding the cause of this peculiar appearance; but with a high magnifying power all doubt vanished. It was then seen to be due to a cellular, or tubular, structure; the whole mass of the mineral being penetrated in two directions by a series of irregularly parallel tubes, or in reality planes of cells, tapering in both directions and appearing like strings of little beads hanging from invisible points. This structure is best seen by using the lower prism ("polarizer") only, and observing the section with the ¼-inch object-glass, when it will appear somewhat like that represented in Fig. 2. Some of the lines of cells are straight, others bent a little, while the intervening portions of the mineral are perforated by very minute solitary cells. A portion of one of the *longitudinal* bands of cells is represented in the upper part of the figure. These are visible with the ¼-inch power in special parts of the thin slice, and though not so numerous as the *transverse* bands, are more continuous. They are also lines or bands of weakness; for in the slice, the margin of which passes across one of those cross-banded felspar crystals, there is always a little notch at the point where the band meets the edge. In speaking of this cross-banded felspar as "orthoclase," I am assuming that the large crystals in the slice belong to the large flesh-coloured crystals in the rock itself, which are known, by the determination of Dr. Haughton, F.R.S., to be orthoclase. Of this I have no doubt; and even if the evidence was less positive under this head, I should have concluded the mineral to be orthoclase from the absence of the fine parallel lines and bands of colour when viewed with polarized light. As regards the arrangement of the longer (or horizontal) bands of cells, my friend Dr. Emerson Reynolds, on viewing the slice, suggested to me that they must coincide with the planes of cleavage of the crystal, as it would be naturally along such planes that the cells, whether filled originally by gas or steam, would arrange themselves. The parallelism of these bands confirms this view.

Mica.—The foliated structure of the granite is well exemplified by the arrangement of the mica in the slice. Besides scattered flakes imbedded both in the silica and felspar, there are three irregularly parallel bands crossing the section transversely, and composed of numerous sets of twisted flakes, sometimes rich brown or bronze in colour, sometimes almost colourless. As usual, they are all deeply scarred, and are sometimes quite opaque, or slightly translucent. One minute crystal, showing the hexagonal form, is inclosed in a cavity in felspar (see Fig. 3). Some of the black specks seen in the mica I suspect to be magnetite, representing the excess of iron over that which has entered into the composition of the mica itself.

The forms, however, are not so satisfactory as in one or two other instances in which I have observed grains of magnetite in the mica of granite, as, for instance, in the granite of Killiney Hill. The mica in the section seldom shows well-defined crystalline forms; and along its margin is entangled with the other minerals, often in so ill-defined a manner as to suggest the idea of a mineral in process of formation. May not this be an appearance due to the metamorphic origin of this granite itself? I am still, however, in doubt, whether the rich bronze-coloured mica is of a different species from the colourless, but equally twisted and scarred variety, seen under the microscope.

EXPLANATION OF PLATE IX.

FIG. 1 *a b.*—Portions of large felspar crystal, showing cross-banded structure with polarized light, mica-flakes in lower part of the field; magnified 25 diameters.

FIG. 2.—Portion of No. 1 magnified 200 diameters, showing cellular structure in both directions; also numerous little cells in the spaces intervening between the lines of cells.

FIG. 3.—Cavity in felspar, with a well-formed crystal of mica (?) and a mica-flake, together with little transparent prisms and grains; magnified 350 diameters.

FIG. 4.—Group of fluid cavities, minute prismatic crystals, and trichites in silica; magnified 200 diameters.

FIG. 5 (*a*).—Fluid cavity in silica; magnified 350 diameters.
(*b*).—The same enlarged; the fluid bubble resting on one side of the cavity.

FIG. 6.—A spherular gas-cell in silica; magnified about 1000 diameters.

FIG. 7.—Spherular cells in silica, from quartz-porphyry of Lesmahago, Scotland; magnified 55 diameters.

FIG. 8.—Part of a mica-crystal, replaced by silica, and containing a spherular gas-cell; Lesmahago; magnified 55 diameters.

FIG. 9.—Crystal of triclinic felspar, probably oligoclase; magnified 25 diameters.

The slices were prepared by Mr. J. B. Jordan, of the *Mining Record* Office.

II.—TERTIARY AND PALÆOZOIC TRAP-ROCKS.

By S. ALLPORT, F.G.S.

MANY Geologists will hail with satisfaction the accession of Prof. Hull to the ranks of the few who appreciate the importance of a microscopic examination of rocks; and the communication from him which appeared in the last Number of the GEOLOGICAL MAGAZINE is the more welcome, as it contains a promise of further researches in the same direction.

In a new line of inquiry, every addition to the number of investigators may be expected to give rise to new views, and produce differences of opinion among those engaged in it. Prof. Hull's paper may be cited as a case in point, for it appears that his observations have already induced him to incline towards an opinion, which my own investigations lead me to reject as untenable.

In the paper referred to, the Limerick traps are described as consisting of augite, felspar, magnetite and olivine, imbedded in a glassy base, the augite occurring in small quantities in the form of scattered crystals and grains. These rocks are then compared with the Tertiary traps of the Antrim area, which are stated to consist of felspar, titano-ferrite, and olivine, imbedded in an augitic base. It is then shown that the relations of the minerals are different in each case, the augite being so abundant in the Antrim rocks as to form the base, while in the Limerick traps it occurs in small quantities, and has crystallized out in individual crystals, bearing a small proportion to the whole mass.

After stating that these facts point to an essential difference in the two magmas, Prof. Hull observes that the distinction here noted between the structure of the Carboniferous and Tertiary augitic rocks is not admitted by me; and concludes with the remark that his own observations tend rather to confirm the opinion of Mr. Forbes, which is, that eruptive rocks of different geological epochs differ essentially in mineral constitution.

I would observe, in the first place, that I certainly am not prepared to admit that a difference in the relative proportions of any of the constituents is sufficient to indicate an essential difference in the rocks in which they occur. My experience is, that there is frequently so great a variety in the relative quantities, and even in the state of crystallization of the minerals, in parts of the same rock, that I doubt the existence of any considerable mass, which would not supply differences quite as great as those pointed out by Prof. Hull.

Examples of such variations are quite common in the Carboniferous and Tertiary dolerites, and are well exhibited in the Antrim traps themselves. I have twelve sections of these rocks, and although neither of them could fairly be described as consisting of a base of augite, containing felspar, etc., I do not in the least doubt that such may occur; for in one of them the augite is very abundant, irregularly crystallized, and is frequently penetrated by felspar; there are, however, numerous felspar crystals forming the usual irregular network, and although the augite presents no definite forms, it is in a perfectly crystalline state, as is evident from its action on polarized light. Another specimen from Ballyclare is a good typical dolerite, containing numerous well-formed crystals of felspar, with grains and crystals of augite and olivine scattered through the mass; another variety contains far more olivine than augite; and a fine-grained basalt from the Giant's Causeway contains innumerable small crystals and grains of augite, felspar, and magnetite in a glassy base.

This glassy base, which is said to constitute a difference between the two series of rocks, certainly occurs in the Antrim basalts, and is common in many Carboniferous and Tertiary dolerites; it can therefore form no ground of distinction between the two.

In the description of the Limerick traps the base is said to be in all cases a glass, and the terms glass base and felspathic base are used indiscriminately. It appears to me very desirable to make a clear distinction between the two expressions; for whatever may be the chemical composition of the substance properly called glass, it is quite structureless, exhibits no trace of double refraction, and therefore always remains dark between crossed prisms. Some of the felspar may also appear dark at the same time, but if the polarizer is rotated a few degrees, and the two prisms again crossed by moving the analyzer, the relative positions of the two sets of optic axes are changed, and the felspar transmits light. Examined in this way I find no traces of glass in a fine-grained specimen from Roxborough, while it is extremely rare in another from Herbertstown, and very abundant in the Rathjordan trap.

Although there are Tertiary basalts which cannot be distinguished from others of Carboniferous age, it is by no means asserted that all Tertiary and all Carboniferous basalts are alike; for great differences certainly exist between augitic lavas of different volcanic districts; the same is true of those of the older geological periods, and similar differences occur between rocks of various periods. It becomes evident, therefore, that a dissimilarity within the range of such variations can give no support to the opinion that there is an essential difference between rocks of different ages. Having now examined a considerable number of rocks from various localities, I intend shortly to publish some of the results, and hope to fully justify the view which I have for some time maintained as to the complete identity in composition and structure of eruptive rocks of widely separated geological periods.

III.—ON THE SARSEN STONES OF BERKSHIRE AND WILTS.[1]

By the Rev. JOHN ADAMS, M.A., etc.

EVERY one who has traversed our Chalk Downs must have noticed here and there shapeless masses of grey stones, half buried in the turf. Sometimes they are found in groups, like the shattered ruins of some ancient temple, and at other times they occur in isolated blocks, as though giant hands had hurled them at random over the hills in wanton sport. At one place, near the village of Kennet, they assume the appearance of a multitudinous flock of sheep, and are known by the appropriate designation of "Grey Wethers," whilst at other places in the same vicinity they bristle on the hill-sides, and trail along the valleys like the débris of an avalanche or the moraine of a glacier. Nowhere do they exist in such profusion as on the west of Marlborough, but they are found scattered over the whole Chalk area of this district. At the western end of it they consist chiefly of saccharoid sandstone. Further east, especially around Newbury, they become smaller, harder, and more crystalline; whilst in the neighbourhood of Great Bedwyn, and occasionally elsewhere, they take the form of pudding-stone, being agglomerations of flint pebbles, cemented together in a matrix of siliceous sand. The name by which these stones are generally known is "Sarsens" or "Sassens," and there are various opinions current concerning the meaning of the word, many of which are so far-fetched and improbable that they are undeserving of notice. Aubrey traces the word to the village of Sarsden, three miles from Andover, and thence to Csar's dene, Cæsar's dene, Cæsar's plain, now Salisbury Plain. "Nat. Hist. of Wiltshire," p. 44. Higgins derives it from a Persian word, "Celtic Druids," p. 5; and Stukeley from the Phœnician language. The commonly received derivation is from

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[1] From the "Transactions of the Newbury District Field Club," 1871. See GEOL. MAG., No. 105, p. 117.

"Saracen," and a writer in "Notes and Queries" thus indorses it (vol. xi. 494): "The Saxons applied the term Saresyn to pagans or heathens in general; and, as the principal specimens of these blocks of stone were perceived to be congregated into temples popularly attributed to heathen worship, it naturally came to pass that the entire formation acquired the distinctive appellation of Saresyn, or heathen stones." Unfortunately for this explanation, we never find the epithet "Saracen" applied to Stonehenge, Abury (or Avebury), or any other heathen temple or monument in this country. Moreover, those stones must have had a distinctive name long before the Saracens were heard of by the Saxon inhabitants of our Chalk Downs; and it is most unlikely that their ancient designation should ever have given place to a foreign word, especially such a vague and inappropriate one as "Saracen" must have been.

Another derivation of the word is from "Sel Stan," great stone; the prefix "Sel" being sometimes used in Saxon topography for great, *e.g.* Selwood; and in support of this notion, I have been informed that in the north of England, isolated masses of rock are called "Selfstone," pronounced "Selsun." The Latin word *Saxum* also has been suggested as the probable root of the name; and as it expresses exactly what Sarsen commonly means, and was doubtless the word by which the Romans designated the stones, it is not impossible that the Belgic Britons of those regions may have borrowed it from them, and handed it down to their descendants, corrupted into "Sarsens."[1]

I would venture, however, to give another derivation which seems to me more probable than the foregoing. The Saxon words "Sar," grievous, troublesome, and "Stan," a stone, are, I believe, the origin of the term. In pronunciation they would naturally become Sarsen, Sassen, or Sarsden; and, moreover, their signification is most appropriate to those stones; for when the downs were first brought under cultivation, the breaking up and hauling away such impediments to the plough, as they were, must have been a very sore and troublesome work.[2]

With regard to the origin of the blocks themselves, theories have been propounded, even more absurd than those concerning their name. Sir Christopher Wren, *e.g.*, thought that they were cast up by a volcano![3] Stukeley's notion[4] was that, because they were of greater specific gravity than the Chalk, they were expelled from that formation by the rotation of the earth! A writer in the "Archæologia"[1] 87 years ago, conjectured that the Sarsens in the neighbourhood of Ashdown Park, were thrown up and scattered over the downs "by an explosion accompanying an earthquake!" Amongst the peasantry the general belief at the present time, like that of Topsy concerning her origin, is that they grew; and are as much a natural product of the soil as mushrooms or thistles.

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[1] I am indebted to Prof. Phillips for this suggestion.

[2] The word "Sar" occurs in the earliest copy of the poem of "Chevy Chase"—

"The dint it was both sad and sar
That he of Montgomry sets;
The swan feathers that his arrow bar
With his hart-blood they were wet."—*Fit ii. v.* 90.

In the preceding verse the word "soar" (sore) is used instead of "sar":—

"A dynt that was both sad and soar."

The Scotch word "sair," signifying *great*, as well as *painful*, best expresses the meaning of the Anglo-Saxon adjective "Sar."—*Note by Edit. N. D. F. C. Tr.*

[3] See Aubrey's "Nat. Hist. of Wiltshire," p. 44.

[4] "Abury," p. 16.

But what are the opinions of Geologists as to the origin and character of these remarkable stones? Various theories have from time to time been advanced, but it is now unanimously believed that they are the remains of Tertiary beds which once overspread the Chalk of this district, but which have been broken up and swept away. With regard, however, to the precise series of strata to which they belonged, there are conflicting opinions.

Mr. Prestwich assigns them to the Woolwich and Reading beds, *i.e.* the mottled clays and sands which in this vicinity immediately overlie the Chalk; and his conclusion is mainly based on this fact, that the sands of that series are of precisely the same mineral character as the blocks themselves. "The concretionary stone,"[2] he says, "in each case represents the component parts of some portion of the Woolwich and Reading series."

A tabular mass, apparently *in sitú*, was discovered some years since at Welford Woodlands, near Hangman-stone Lane, in a thin outlier of those beds. It was 10 or 12 feet in width, and lay horizontally within a few inches of the Chalk. As its surface was barely plough-deep, it was thought expedient to get rid of it; and after attempts were made in vain to break it up, a pit was dug on one side of it, into which it was tilted. In making the excavation the edges of three other tabular blocks were laid bare, all lying horizontally at the same depth on reddish clay. One of them, which I uncovered a short time since, is of enormous dimensions, being 9ft. 6in. by 9ft. and 25 inches in thickness. A ploughman informed me that in cultivating the field, the surface of others are sometimes touched near the same spot; and small stones of similar character abound in the vicinity, expecially where pits have been dug for chalk. Masses of similar stone occur also in the same formation at Langley Park, near Beedon, and are resting unquestionably on the very spot where they were consolidated. They are imbedded in sand somewhat stained with oxide of iron, and may be dug out in nodules of all sizes, and of every degree of hardness. Some are so soft that they may be knocked to pieces by a gentle blow of the hammer; whilst others have the toughness and close-grained structure of the most compact Sarsen. Most of them, however, are coated with sand which is imperfectly solidified, but which gradually merges into the crystalline character of the block; and the process of agglomeration seems to have been carried on by accretions of pure sand gathering round the mass on all sides. Generally those accretions appear to have taken the form of balls, varying in size from a pea to a walnut; and they now give a very picturesque aspect to the stones, causing many of them to resemble huge clusters of Coral.

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[1] Vol. viii., p. 442.

[2] Quart. Journ. Geol. Soc., vol. x., p. 123.

But it has been demonstrated that the Sarsens may be traced to other beds as well as to the Lower Eocene. Mr. Whitaker, whilst admitting that many of them must owe their origin to the Woolwich and Reading series, assigns those in our district chiefly to the Bagshot Sands, which once overspread this end of the London Basin,[1] but have been in great measure denuded; and inasmuch as they are often found resting on London Clay, which intervenes between the Bagshot Sands and the Woolwich and Reading beds, there can be no doubt of the soundness of his argument. Moreover, he shows that, west of Newbury, the Lower Eocene strata gradually thin off, and terminate altogether near Marlborough; whilst there is reason to believe that the Bagshot Sands overlapped them on the west, and rested directly on the Chalk; and it is just on that margin, over which the lowest beds never seem to have spread, that the Sarsens are most abundant. His reasoning may furthermore be strengthened by a circumstance which he has not mentioned, viz.: that, like the Bagshot Sands in this district, the Sarsens are entirely destitute of fossils; whereas, if they had been formed only in the underlying beds, this would not always have been the case, inasmuch as those beds are sometimes fossiliferous.

Whatever their geological parentage may have been, it is certain that they have not travelled far from their native home; for many of them have angles almost as sharp as blocks newly quarried; and specimens which have been rounded by friction are very rare.[2]

We may fairly assume then that those singular stones are the remains of various Tertiary strata, which at some remote time covered this district; and that they owe their anomalous position to the denudation which has dislodged them from their beds, and swept away the parent sands and clays in which they were formed.

What a strange history theirs would be, if they could unfold to us the vicissitudes through which they have passed! Ages ago, long before this earth was peopled by human beings, the whole of this region lay buried beneath the sea; and the water, charged with silex, here and there cemented its sandy bed into compact blocks of stone. Why the process of consolidation should have gone on only in particular places, and not throughout the whole mass of sand, it is no easy matter to explain. But so it seems to have been. Sometimes stems of Fucoids were buried and sealed up in the incipient rocks, leaving a vacuum as they decayed within the solid substance of the stone. Sometimes, too, Molluscs would bore for themselves a home in their sides, just as we see similar creatures burrowing in the rocks of our modern sea-coasts. How else can we account for the winding root-like holes with which many of them are perforated? After they had grown old, humanly speaking, in their original bed, the sea withdrew from them, and left the sand exposed to the wasting influences of frost and sunshine, storm and rain. Consequently, as the ages rolled on, layers of them were uncovered, and the softer parts decayed under the subaerial agencies which unceasingly acted upon them. Hence the weather-worn corroded faces which many of them now present; effects which could not have been produced within the human era, because they are apparent on those which are disinterred from clay-pits, as well as on the surface blocks. Subsequently, through some convulsion of nature which depressed the dry land, the sea returned for a time to its former bed. Tides and currents in some places undermined their foundations, lowering them till they rested upon the ancient Chalk formation, and at others overwhelming them by deposits of sand and clay. Surging waves pounded all that were soft and friable to their original elements, and scattered small nodules, too hard to be crushed, broadcast everywhere; so that we can easily understand how it is that so many triturated fragments of Sarsens are now found in our gravel-pits, and why it is that the masses on our downs are scattered about in such profusion.

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[1] Quart. Journ. Geol. Soc., vol. xviii., p. 271.

[2] For figures and descriptions of some water-worn and rounded Sarsen stones from the neighbourhood of Southampton, see Geol. Mag., 1866, Vol. III. p. 296, Plate XIII.

Since they were stranded where they now lie, they have been rapidly diminishing in numbers; for, like everything else among the natural stores which God has given us, they have an economical value. Several examples remain of the way in which they were utilized in primeval times. The huge tri-lithons of the outer circle at Stonehenge, the stupendous temple of Abury, the cromlech at Clatford, and Wayland Smith's cave, were all constructed with Sarsens; and in modern times they have been extensively used for various purposes. We find them in the foundations of churches and old houses in this district, many of our streets are paved with them, and they are still quarried and broken up in certain places for building materials.

Well may those venerable relics of a former world be called Sarsens, or "sad stones." Their name, if such be its meaning, has a fitness far beyond that which the unlettered Saxon dreamt of when he gave it; for they are the waifs and strays of an appalling wreck, and their condition is akin to that of shipwrecked mariners on some foreign shore. They are, in fact, the lonely survivors of a land which the wasting elements have dissolved, and the floods have utterly swept away.

IV.—ON FISSURES, FAULTS, CONTORTIONS, AND SLATY-CLEAVAGE.[1]

By CHARLES RICKETTS, M.D., F.G.S.

IT was contended in a previous communication[2] that all valleys have been formed by sub-aërial agencies alone, and that the disintegrated materials, being carried seaward by the rivers traversing them, have accumulated to immense thicknesses in what had been formerly a continuation of these valleys, and have, by their weight, caused progressive subsidence, and so have formed bays and to some extent deltas at and near their mouths.

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[1] An Abstract of a paper read before the Liverpool Geological Society as the President's Address for the Session 1872-73.

[2] "On Subsidence as the Effect of Accumulation," GEOLOGICAL MAGAZINE, 1872. Vol. IX., p. 119.

As a consequence of subsidence in one place, there must of necessity be elevation in another. Elevation would also result from the removal of pressure. The subject was then alluded to only for the purpose of accounting for the partial emergence of the land, upon the melting of the snow which covered its surface during the Glacial period; but it continually happens that those strata which are physically highest above the sea-level, are geologically the lowest in the series, the greatest amount of upheaval occurring where denudation has taken place to the greatest extent.

These innumerable evidences of changes of level occur in all parts of the globe; they date from the earliest period registered in the geological record, and extend down to the present time. Their occurrence cannot be so general, or their progress so continuous and gradual, if the interior of the earth is not to a certain extent in a state of fluidity, and covered with what, compared with the whole mass, must be a thin crust.

It is very generally conceded that "the effect of elevatory force by raising the mass under which it acts, would place the strata in a state of extension, and therefore of tension," which continuing will produce fissures even so as to extend through the whole thickness of the earth's crust. To fractures thus induced the volcanos of the Andes may be attributed. But a similar result has not so frequently been ascribed to the effect of subsidence, though tension and extension, and therefore fissures, must occur under such circumstances, commencing from a depth coinciding with that of the chord of the arc of the earth's circumference included within the subsiding area. That such fissures do occur in areas which are those of depression is proved by volcanos being frequently situated in localities known to be subsiding, and the presence of Trappean rocks is very frequent in the Palæozoic formations of Britain interstratified with sedimentary deposits; they were at their respective periods erupted, and poured forth either as volcanic ash or lava-flows in areas which were not only subaqueous but also subsiding, as is proved by the large amount of subsequent accumulations.

An examination of Trappean dykes tends to prove that the molten rock "has been forced up through previously formed fissures to a certain height," in its passage baking but not disturbing the rocks which form the walls of the fissures. Lava can only proceed so far as the fracture extends, and, as in subsiding areas there must be compression of the *upper* strata, it can only make its way upwards, as such, so far as the chord of the arc before referred to. The only manner by which I can suppose the vent to be formed in such a case is by water, on obtaining access at a greater or less depth to the ncandescent lava contained in the fissures, exploding, and carrying away the superficial strata; for it frequently happens that in what n all probability are the pipes of volcanos passing through contemporaneous strata, there is no appearance of fracture or fault extending to a distance into the sedimentary rocks. This coincides also with the general sequence given of volcanic phenomena, which more frequently commence with an explosion of steam and gases, carrying upwards immense quantities of scoriæ and ashes, and not unfrequently blowing off the summits of cones formed by previous eruptions. Such explosions may be compared to those induced by water obtaining access to metal molten in a crucible, and the effects are very similar. This state, after continuing for a time, is followed by streams of lava, which "well out, sometimes almost with the tranquillity of a water spring, from the same or contiguous openings."

Most remarkable has been the intrusion of lava between beds. However powerful the force which has produced this effect, there is in innumerable instances no indication of violence. Belts of Greenstone and Basalt have been frequently insinuated between the strata, so exactly in the direction of the bedding, that were those situated above not altered by heat as well as those below, it would be with great difficulty determined that they were intruded, and not interstratified.

There is much proof of a local connexion between volcanos and earthquakes; the former being generally preceded and accompanied by the latter. Earthquake-shocks are far from being confined to the neighbourhood of volcanos.[1] They appear to be prevalent in localities which there is reason to conclude are areas of elevation or else of depression. In endeavouring to account for their production, those who have paid most attention to the phenomena accompanying them appear entirely to overlook the geological changes produced by faults, each of which must be a register of at least one, and most, in all probability, record a succession of earthquake-shocks.

Previous to a fault being formed, a fissure must have taken place in the crust of the earth, and have progressed so as to cause a greater or less interval between the sides of the fissure. This will occur either upon depression or elevation of the surface, increasing as the depression or elevation becomes greater. Should there be a stratum so far unconsolidated that (as the rocks have lost their lateral support by the separation of the sides of the fissure), it cannot support the pressure of the overlying beds, the result must be that wedge-shaped masses will separate and fall or slip downwards, in a manner similar to what occurs to a block of masonry, however solid, if its foundations are undermined; or in the same manner as that of landslips along our coasts, only that in faults the wedge-like mass is checked when it comes in contact with the opposite side of the fissure, causing that thud or blow which occasions the vibration of the earth's surface, and constitutes the earthquake.

Few, if any, will now believe that any great faults are the result of one single movement, but that they are rather to be attributed to a long succession of displacements; and it is likely that some do not, through their whole extent, belong to the same geological era. Faults not unfrequently have caused enormous dislocations of the strata; in North Wales to the extent "of 2,000, 5,000, or even 12,000 feet." Immense wedge-shaped masses, such as in these cases have fallen downwards and filled up what would otherwise be extensive chasms in the earth's crust, have increased to some extent the superficies of its surface.

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[1] See Scrope, "Volcanos," p. 8.

The displacement or downthrow which occurs on the formation of a fault is simply a falling or slipping downwards of separated rock-masses along planes of fracture; it is evident that by such movement the strata cannot become bent or contorted, nor can the original direction of the dip be altered, for the mass is prevented from tilting over in consequence of the impulse being checked by the opposite wall of the fissure.

Slickensides are frequently met with in connexion with faults, and indicate the direction of some movement which has taken place. They may sometimes have been caused by the friction induced on the occurrence of a fault, but in such a case the striations could only have a direction downwards along the hade of the fault. Such is the direction of the marks in the principal or north and south faults, of this district (the neighbourhood of Liverpool); but as the strata have been subsequently exposed to compression at right-angles to these faults, it is to the latter circumstance their presence must be attributed, for the action of the second movement would obliterate the effects of the first. In those faults having an east and west direction, or nearly approaching it, the striations are sometimes nearly horizontal; in others, and more frequently, more or less oblique, and seem to indicate that in the one case there has been a lateral movement, in the other that, in addition to this, there has been at the same time an amount of upward pressure. As the lateral pressure by which these Triassic rocks have been acted on has been in an east and west direction, the tendency would be, in the instances referred to, to compress into a less lateral compass the slightly consolidated beds of the Upper Bunter Sandstone, and, by causing a re-arrangement of the particles of which they consist, or by inducing foldings in the beds, occasion some amount of elevation of the superincumbent strata, and the movement thus produced would cause that friction along the sides of faults which has rendered their surfaces polished and striated.

The opinion of Sir James Hall, illustrated by him in 1813, that contortions and flexures of stratified rocks have been the result of lateral compression, forcing the strata more closely together laterally, but elongating and making them to rise upwards in a direction perpendicular to the pressure, is generally accepted. The principle is even admitted by those who attribute these foldings to the effect of upheaval alone; but "that would stretch instead of crumpling the surface," and therefore contortions under such circumstances would be impossible.

The researches of Sedgwick, and of Phillips, of Sharpe, Sorby and Tyndall, have successively demonstrated that cleavage differs essentially from stratification, being the result of a change in the structure of sedimentary rocks; due to mechanical causes; and that it has been induced by pressure of the mass in a direction perpendicular to the planes of cleavage.

Observation thus proves that changes in the dip of strata, contortions, and cleavage, have been induced by lateral pressure, often propagated in the same direction over extensive areas, and in innumerable instances the same force has caused both the contortion and cleavage.

Sir Charles Lyell, in 1850, suggested that to some extent flexures might be caused by the subsidence of mountainous masses beneath the floor of the ocean, which, sinking for miles vertically, must occasionally be forced to pack themselves into smaller spaces than they previously occupied.[1] Depression must necessarily cause compression of the subsiding portion, until a certain depth is reached, but as it acts in every direction, the contortions must be irregular, unless there exists some cause to give that definite tendency which they so frequently assume. The chief causes capable of producing this effect appear to be valleys and faults.

Valleys at their seaward extremities become gradually submerged and filled up with sedimentary matter brought down by rivers. If this depression continues, compression must be induced, and the unconsolidated material, confined as it were between walls of hard rock, would have the direction of the pressure applied to it determined by that of ancient submerged and filled-up valleys. Therefore the hollows and ridges of the contortions would extend parallel to the course of the valley; the flexures being greater near the sides, in consequence of the resistance afforded by the harder rock. The greatly contorted Silurian strata to the west of the Malverns may be cited as an example.

As cleavage is dependent on similar pressure, so likewise it would be induced under the same circumstances if the conditions are favourable. To such an origin I would attribute the cleavage as well as the contortions of the Wenlock rocks, at a distance of four miles to the north and the same to the south of Llangollen; these strata appear to be a deposit in a pre-Wenlock valley.

The presence of dykes, or other masses of intrusive volcanic rock, by forming points of resistance, have, upon the occurrence of similar changes of level, also influenced the formation of contortions.

A more powerful agent in influencing the degree and direction of pressure is the occurrence of faults; and it is generally recognized that their presence has "an intimate connexion with those foldings which constitute anticlinal and synclinal axes." But their formation must be attributed to a different movement from that by which faults have been produced. The wedge-shaped masses, which have fallen down on the formation of faults, have by so much enlarged the area they occupy, as the width of the angular portion is increased from the original width at any point previous to the dislocation; but there would be no difference, or very little, in the angle at which the depressed portion lies from that which it previously occupied.

As the space occupied by the occurrence of faults, whether they result from depression or from upheaval, is larger than it was originally, upon a change to upheaval or depression, as the case may be, the strata must be compressed into a smaller compass, and therefore foldings and contortions will be induced, the general direction lengthwise being the same as that of the faults. This same action would originate cleavage, but not in any beds which have been elevated above the sea-level, as, in consequence of the drainage of the water they contain, such consolidation would take place that the necessary movements amongst their constituent particles would be rendered impossible.

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[1] Presidential Address, Quart. Journ. Geol. Soc., vol. vi., p. liv.

This method of accounting for the production of contortions was first proposed by Prof. Phillips in 1848,[1] and was afterwards, but independently, used by the late Prof. Jukes, to account for the formation of certain contortions observed by him in the Coal-strata of Staffordshire.[2]

In this and in a previous communication (Geol. Mag., Vol. IX., p. 119) my endeavour has been to prove the strict interdependence of geological phenomena. Change cannot take place in one direction without causing alteration in another. Prolonged and almost imperceptible are the actions that have produced the immense amount of denudation on the earth's surface; fully as slow has been the redeposit in other localities of the debris resulting from that denudation. The most enormous contortions, and the most abrupt bendings of strata, as well as that change in the position of the constituent particles by which slaty cleavage has been induced, have occurred in the most gradual manner. They have been effected with great power, it is true, but without violence. I believe the time must shortly arrive when it will be generally accepted by geologists that "the most gigantic curvatures of strata have been the result of intense pressure so moderated in its application as to have been just sufficient to overcome the resistance opposed to it, and that this motion has been as insensible as the unfolding of the petals of a flower."[3] Even the volcano and the earthquake must be removed from the category of cataclysms and convulsions. With more probability may they be considered as the necessary result of those slow and imperceptible changes, by whose accumulated power certain physical alterations have been made in the earth's crust. In conclusion, I must express my conviction that a careful examination of the phenomena under consideration will demonstrate that the prime mover which has produced them is denudation, with its consequent deposition, acting and re-acting on the crust of the earth, equally balanced on its fluid interior.

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[1] Memoirs of the Geological Survey, vol. ii. Geology of the Malvern Hills, p. 142.

[2] Student's Manual of Geology, chap. xiii.

[3] Sir C. Lyell, Presidential Address, 1850, Quart. Jour. Geol. Soc., vol. vi., p. lxiii.

V.—ON THE JURASSIC FORAMINIFERA OF SWITZERLAND:[1] being a Critical Examination of the Species Described and Figured by MM. Zwingli and Kübler.

By Professor T. RUPERT JONES, F.R.S., F.G.S.,
of the Royal Military and Staff Colleges, Sandhurst.

THESE Foraminifera were obtained from fifteen zones of the Jurassic strata, between Solothurn, in Switzerland, and the Eichberg, in Baden: three Liassic zones (Black or Lower Jura); six in the Brown or Middle Jura; and six in the White or Upper Jura; beginning with the Turneri-zone of the Lower Lias, and ending with the Pteraspis-zone of Schaffhausen. The Numismalis-marl, Amalthei-clay, Murchisonæ-bed, Discoidei-marl, Crenularis-bed, the Coral-limestone, and the Virgulian stage yielded few or no traces of Foraminifera.

The descriptions and figures of what Dr. Kübler determines as 153 species have had much care bestowed on them; but the artificial classification (D'Orbigny's), and a want of rigid comparison and discrimination of specific forms, betoken an imperfect knowledge of Foraminifera and a very limited appreciation of the works of previous observers (although some are mentioned),—such as F. A. Römer (1836), D'Archiac (1843), Buvignier (1852), Bornemann (1854), Terquem (1858 to 1870), Gümbel (1862), Brady (1867), Schwager (1867), besides D'Orbigny and Strickland, who have treated of Jurassic Foraminifera; for species and varieties already figured and named are in this work re-named again and again.

A still larger field for comparison is to be found by taking into view the very similar Microzoa obtained from the Rhætic and Triassic formations, and figured by Jones and Parker (1860), Gümbel (1861, 1869), Schwager (1864, 1870), and Reuss (1866, 1867, 1868).

The Swiss specimens are mostly figured as transparent or subtransparent objects, with transmitted light; the opaque (porcellanous and arenaceous) species are therefore among those that have perspective figures, excepting when they are sufficiently thin, as some *Miliolæ* and *Cornuspiræ*, to be subtranslucent.

Hesitating to labour through the very numerous figured varieties of Jurassic Foraminifera industriously embalmed in the plates of this work and those of the authors above mentioned, for the purpose of reducing them to their really few species, it is proposed in this instance to indicate broadly the foraminiferal fauna of each stage, as detailed by Dr. Kübler, and to offer some remarks on the more striking features, and on the more interesting figures. The names assigned to the figured forms are generally of very little worth; the generic appellations in many cases will have to be corrected; but we shall rarely trouble to correct the trivial name; for, besides the twenty acknowledged recurrent forms, numerous individuals of evidently the same species, and even of the same variety, have been endowed with new names.

The generic and quasi-generic groups will indicate the relative proportion of special forms in each of the stages treated of, the names, on which the numbers will be founded, being here rarely little more than indicative of individuals, or at most of sub-varieties.

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[1] Die Foraminiferen des Schweizerischen Jura, etc. By the late Pastor H. Zwingli and Dr. J. Kübler. 4to. pp. 49, with 179 lithographic figures in 4 Plates. (Winterthur, 1870.)

The figures themselves, having been carefully drawn, are useful as a collection of specimens, ready at hand, exhibiting shades of difference, as well as the general *facies* of the several foraminiferal faunæ, such as can scarcely be shown in words.

I. The Lias: Black Jura.—A. The Lower Lias. Turneri-clay of the Schambelen, Canton Aargau; immediately above the Arietes-limestone, β of Quenstedt. Pp. 5–7; pl. 1, i., figs. 1–18.

Nodosariæ 3; Vaginulinæ 5; Frondiculariæ 5; Cristellariæ 3; Textilaria 1; Biloculina 1. The *Nodosarinæ* (figs. 1–16) are varieties of *N. radicula* and other common species (or varieties), already well known. The gradational stages from the subcylindrical, costate, and limbate *Nodosaria* to its flattened Frondicularian form, are clearly seen in figs. 2, 11, and 9. *Text. prodomus* (fig. 17) is a common variety of the "Sagittula" group. *Biloc. liasica* (fig. 18) wants definition, but may well be a Biloculine *Miliola.*

B. Middle Lias. The Numismalis-marl of Frick yielded nothing.

C. Upper Lias: Toarcian. 1. Posidonia-shale; ε of Quenstedt. From the Commune of Klingau, S.W. of Zurich, Canton Aargau; and from near Schleitheim, Canton Schaffhausen. Pp. 8, 9; pl. 1, ii., figs. 1–6.

Frondicularia 1; Vaginulina 1; Cristellariæ 4. Common and well-known feeble forms, not requiring new names.

2. Jurensis-marl (immediately above the Posidonia-shale); ζ of Quenstedt. From Vetznau. Pp. 10–12; pl. 1, iii., figs. 1–12.

Nodosaria 1; Frondicularia 1; Cristellariæ 7; Flabellina 1; Ophthalmidium 1. Figs. 1–10 are well-known *Nodosarinæ,* already named; among them figs. 3–10 show the passages from *Cristellaria* to *Flabellina. Ophthal. liasicum* (fig. 11) is the central Cornuspiral or Adelosine commencement of a *Miliola.*[1] A *Chirodota* (fig. 12) is recognized in the text as belonging to an Echinoderm.

II. Middle or Brown Jura: Dogger. A. Bajocian: Aalen-series: Lower Brown Jura. *a.* Opalinus-clay of the Schambelen: and α of Quenstedt: immediately above the Radians-bed. *b.* Opalinus-clay of Vetznau. Pp. 13–15; pl. 2, i., figs. 1–7.

Cenchridium 1; Lagena 1; Cornuspira 1; Frondiculariæ 2; Dentalina 1; Cristellaria 1; Ophthalmidium 1.

Cenchr. Aargovense (fig. 1) and *Lagena Aargovensis* (fig. 2) are the long and the short varieties of *Lagena globosa. Cornusp. Helvetica* (fig. 3) is a very interesting example of *Spirillina.* Figs. 4–6 (*Nodosarinæ*) were not worth naming anew; indeed fig. 5 is equal to fig. 2, i., pl. 1. Fig. 7 (*Oph. porosum*) is a Spiroloculine *Miliola,* probably *punctate,* although described as being *porose* (see further on).

c. Blagdeni-bed, immediately above the Humphresianus-bed, but below the main oolite of the Middle Brown Jura: δ of Quenstedt. From the Vetznau. Pp. 15–17; pl. 2, ii., figs. 1–12. Nodosariæ 3; Frondiculariæ 3; Marginulina 1; Cristellariæ 2; Flabellina 1; Ophthalmidium 1.

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[1] See further on in the notice of the "Appendix."

Figs. 1–10 are already named *Nodosarinæ* (fig. 10 is intermediate to figs. 9 and 10, iii., pl. 1); figs. 11 and 12 (*Oph. carinatum*) represent a Spiroloculine *Miliola*.

B. Bathonian: Middle Brown Jura. Parkinsoni-clays: *ε* of Quenstedt. *a.* From Fuetzen, Baden. *b.* From Bargen, Canton Schaffhausen. Pp. 17–19; pl. 2, iii., figs. 1–11.

Lagena 1; Cornuspiræ 3; Nodosariæ 2; Vaginulinæ 2; Cristellariæ 4; Ophthalmidium 1.

Lagena Parkinsoni (fig. 1) is *L. globosa*. *Cornuspira Eichbergensis* (fig. 2) is a *Spirillina*, possibly the same as fig. 3, i., pl. 2. Figs. 3 and 4 (*Cornusp. elliptica* et *gracilis*) appear to be varieties, orbicular and elliptical, of *Trochammina incerta*, though *gracilis* is said to be transparent. Figs. 5–9 are common well-known *Nodosarinæ*. Figs. 10 and 11 (*Oph. Okeni*) are Spiroloculine *Miliolæ*.

C. Callovian: Kelloway group: Upper Brown Jura. *a.* Lower division. Macrocephalus-bed, from the Eichberg, near Achdorf, Baden. Pp. 19–21; pl. 2, iv., figs. 1–14. Lagena 1; Cornuspiræ 2; Vaginulinæ 3; Frondiculariæ 2; Cristellariæ 8; Nonionina 1.

Fig. 1 (*Lag. minutissima*) is the common little *L. globosa*. Fig. 2 seems to be a *Spirillina* from the description (colourless, transparent); but it may prove to be a *Cornuspira*. The other so-called *Cornuspira* will be a *Trochammina*, if its correlation with the foregoing *C. elliptica* be correctly indicated. Figs. 3–13 are various common *Nodosarinæ*, unnecessarily named afresh. Fig. 14 is not a *Nonionina*, but probably a *Planorbulina*.

b. Ornati-clay: Upper division of the Callovian stage: *ζ* of Quenstedt. Pp. 21–23; pl. 2, v., figs. 1–7.

Lagena 1; Cornuspira 1; Dentalina 1; Frondicularia 1; Cristellaria 1; Flabellina 1; Ophthalmidia 3.

Cornusp. Biedermanni (fig. 1) is probably a true *Cornuspira*.[1] The *Nodosarinæ* (figs. 2–5) did not require new names. Fig. 6 (*Oph. carinatum*) is a Spiroloculine, and fig. 7 (*Oph. multiplex*) a Quinqueloculine *Miliola*.

III. Upper or White Jura. A. Lower White Jura: Oxfordian.

1. Birmenstorf-bed: Transversarius-zone (Oppel). *a.* From the Rebberg of Birmenstorf, Baden. *b.* From the Eichberg. Pp. 24–33; pl. 3, figs. 1–50.

Lagena 1; Cornuspiræ 3; Frondiculariæ 2; Nodosariæ 3; Dentalinæ 3; Vaginulinæ 9; Marginulinæ 5; Cristellariæ 12; Robulina, 1; Nonionina 1; Globulina 1; Vulvulinæ 3; Textilariæ 2; Ophthalmidia, 6.

Fig. 1 (*Lagena Helvetica*) is *L. lævis*. *Cornusp. Eichbergensis* (fig. 2) and *C. concava* (fig. 3) are orbicular and elliptical individuals of *Trochammina incerta; C. gracilis* is also mentioned, which, according to its figure (pl. 2, iii., fig. 4), appears to be a *Trochammina*, although it is said to be transparent (the thick edge, however, is duller and yellow, p. 17). Figs. 4–38 are various *Nodosarinæ*, each of which falls under some well-known name or another. *Nodosaria radicula* and *Dentalina communis* respectively mprise several of them. Figs. 6, 7, and 8 are curious extremes of e moniliform *Nodosariæ* (*N. pyrula*, etc.). Figs. 20 and 20*a* show ι extremely simple form of *Cristellaria*, near to *Planularia pau-rata.* Fig. 22 has its analogue in the Chalk; and, indeed, all are mmon, widespread, and persistent varieties. The relatively large ;. 33 is *Cristellaria* (*Planularia*) *crepidula.*

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[1] See further on, where the Appendix on *Cornuspira* and *Ophthalmidium* is noticed.

Fig. 39 (*Nonionina Birmenstorfensis*) is probably a *Planorbulina.* igs. 40 and 40*a* (*Globulina Helvetica*) are *Polymorphina liasica*, rickland, and an approximate variety. Fig. 41 (*Vulvulina farcimen*) a *Virgulina*, having the early chambers heaped. Figs. 42 and 43 *'ulv. minutissima* and *V. Eichbergensis*) are loose-grown pouting *xtilariæ;* and 43*a* appears to be a *Textilaria* of the same habit of owth, but with the normal aperture. Figs. 44–45*a* are *Textilariæ* the common "sagittula" type; and fig. 45*a* has the not un-mmon spiral commencement, which gave rise to the quasi-generic ıme "Spiroplecta." Fig. 46 (*Ophth. Birmenstorfense*) is a Spiro-culine *Miliola;* 47–49 (*Ophth. gracile, medium*, et *auris*) are Quin-ıeloculine; and 50 (*Ophth. cornuspiroides*) represents the early ıambers of a similar *Miliola.* A *Chirota* is also figured.

2. Effing-beds; Impressa-clays (*Terebratula impressa*) of Quen-edt. From the Eichberg, Grand Duchy of Baden; Siblingen, ınton Schaffhausen; and Baden, Canton Aargau. Pp. 33–36; . 4, i., figs. 1–17. Lagena 1; Cornuspiræ 5; Frondicularia 1; entalina 1; Vaginulinæ 2; Cristellariæ 6; Rotalina 1; Rotalia 1; lobulina 1; Vulvulinæ 2; Textilariæ 2.

The *Lagena* is *L. lævis.* Of the "Cornuspiræ," figs. 2–4 represent *'ochammina incerta*, and figs. 4*a* and 4*b* show passages from the me towards *Tr. gordialis.* The *Nodosarinæ* (figs. 5–13) are mmon, well-known, variable forms, which have been named again ıd again.

Fig. 14 (*Rotalina Badensis*) may possibly be a *Planorbulina;* but r more probably it is a rotaline *Lituola* (*Endothyra*). Fig. 15 *lotalia Siblingensis*) is not a *Rotalia*, but probably a *Planorbulina.* he *Globulina* is *Polymorphina liasica.*

Figs. 16-17*a* (*Vulvulinæ* and *Textilariæ*) are well-known *Texti-riæ*, occurring at many other horizons, and already named more an once.

B. Middle White Jura: Corallian stage: Geissberg-beds (with ıd without Nullipores[1]), Baden, Canton Aargau. Pp. 36–37; .. 4, ii., figs. 1–3.

Cornuspira 1; Vaginulinæ fragments; Cristellaria 1; Robulina ; Nonionina 1; Ophthalmidia, fragments.

The "Cornuspira" is a *Trochammina* (see pl. 3, fig. 2). The *'odosarinæ* have been previously named and re-named. The "Nonio-ına" is the same as pl. 3, fig. 39, and probably pl. 2, iv., fig. 14, ıd should be classed with *Planorbulinæ*, being not far removed om *Pl. ammonoides.*

C. Upper White Jura: Kimmeridgian stage. 1. Astartian forma-on, Rödersdorf, Canton Solothurn. Pp. 37–38; pl. 4, iii., fig. 1. *Rotalina Moeschii* (fig. 1) is relatively large, and probably a

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[1] See GEOL. MAG., No. 105, p. 122.

Planorbulina. It differs from fig. 15, pl. 4, i., in its greater number of chambers, and in its septal lines being excavated instead of being filled up with shell-matter (limbate).

2. Strombian formation: Baden-bed of the Eastern Tunnelwand of Baden, Canton Aargau: "γ alba" of Quenstedt. Pp. 38–39; pl. 4, iv., figs. 1–10.

Lagena 1; Cornuspiræ 5; Dentalina 1; Cristellariæ 5; Nonionina, 1; Textilaria 1; Ophthalmidia, fragments.

Lagena Badensis (fig. 1) is *L. lævis.* *Cornusp. Eichbergensis* (fig. 2) is said to show pores when magnified 400 diameters; if so, it is a *Spirillina;* but its habit is decidedly that of a *Trochammina.* (Pl. 3, fig. 2, p. 24, also "*C. Eichbergensis,*" is a *Trocham. incerta,* both by figure and description.) *C. elliptica* (fig. 3) is an elliptical *Tr. incerta.* Fig. 4 (*C. convexa,* yellowish-grey, transparent; pores doubtful) appears to be a true *Cornuspira,* or a Cornuspiral *Miliola,* very thin. The "Nonionina," being referred to pl. 4, ii., fig. 3, must be regarded as a *Planorbulina.* The *Nodosarinæ* (figs. 5–9) do not at all require new names.

3. Rhinefall-rock: Steraspis-zone (Oppel): "δ alba" of Quenstedt (?). Lohn and Bargen, Canton Schaffhausen. P. 40; pl. 4, v., figs. 1–3.

Cornuspira 1 (=*Trochammina?*); Vaginulinæ 2 (varieties of *Dentalina communis*); Robulina 1; Textilaria 1; Vulvulina 1 (=*Textilaria* or *Virgulina?*). Chirodotæ are also mentioned, and one is figured.

Appendix: pp. 45–47; pl. 4, vi., figs. 1–5.

Cornuspira Bayonnensis (fig. 1) and *C. undulata* (fig. 2), from the Tongrian Tertiary beds of Bayonne, are either true *Cornuspiræ* or young Cornuspiral *Miliolæ.* *Ophthalmidium tongricum* (figs. 3 and 4), from Bayonne and Dalsberg, and *Oph. superbum* (fig. 5), from Bayonne, are *Miliolæ;* the former Spiroloculine; the latter Quinqueloculine, probably punctate or reticulate. They are all represented as seen with transmitted light, like the majority of the specimens figured in this memoir.

1. *Cornuspira* is here described as having both porose and non-porose species; the division of the simply spiral, discoidal Foraminifera into *Cornuspira, Trochammina,* and *Spirillina,* according to structure and habit of shell, not being known, apparently, to Dr. Kübler.

2. *Ophthalmidium* (formerly called "*Oculina*" by Zwingli and Kübler) is defined as having a somewhat Spiroloculine growth, but never being complanate, always attenuate at the ends, and always commencing with a curved subdiscoidal chamber. It may seem convenient to recognize this as a modification of *Miliola,* especially because the early chamber (or rather the early tubular, continuous, and rarely segmented chambers) of such forms is Cornuspiral,—that is, zoologically equivalent to an incipient *Cornuspira.* Indeed, when separate, such specimens cannot be distinguished from young or arrested individuals of that genus, which, however, in its full development affects the flat spiral habit of growth, as *Miliola*

ffects the half-turn envelopment, on one, two, or three planes. The *Adelosina* of D'Orbigny, however, is just this young state of *Miliola*, constructed in the same subdiscoidal form, and has been recognized as the general type of young *Miliolæ*. The subsequent plan of growth is so much varied (within certain limits) as to give room perhaps for the somewhat convex Spiroloculine form indicated by "*Ophthalmidium*," though not of special value. What is of more importance is Dr. Kübler's statement as to the *porosity* of some of these individuals, such as pl. 4, v., fig. 5 (*Oph. superbum*), and pl. 2, i., fig. 7 (*Oph. porosum*). Although Dr. Kübler warmly and conscientiously avows his belief that these are not merely *punctate* shells, we cannot help thinking that the microscopic appearances, with transmitted light, in specimens mounted with turpentine or balsam, have deceived him. The larger perforations noticed in the specimens appear to be accidental, and not in anywise essential.

The several Foraminiferal groups above treated of are evidently members of one fauna, existing through the Jurassic period, without undergoing any great modifications. Indeed the same fauna is fully recognizable in the Triassic strata. The Swiss specimens under notice comprise Cornuspira; Miliola (Biloculina, Quinqueloculina, Spiroloculina); Trochammina; *Endothyra* (?); Nodosarina (Lagena, Nodosaria, Dentalina, Vaginulina, Marginulina, Frondicularia, Flabellina, Cristellaria, Planularia); Polymorphina; Textilaria; Virgulina; Spirillina; Planorbulina.

The *Miliolinæ* appear to be more fully represented in these Jurassic beds of Switzerland than in those of other countries. The rotaline *Lituola* ("*Rotalina Badensis*"), or *Endothyra* (?), of the Oxfordian of Effing, is interesting (if it be sandy, as we presume), being of the curious series of arenaceous Foraminifera that imitate the hyaline forms, and among which the Lagenoid, Flabellinoid, and Marginulinoid *Lituolæ*, figured by Terquem, from the Inferior Oolite (Parkinsoni-bed), are well-marked types.

The *Nodosarinæ* are abundantly represented, mostly by very simple, feeble, and variable forms, as is usual in the Triassic, Rhætic, and Jurassic strata.

Spirillina Helvetica, from the Middle Brown Jura (Opalinus-clay and Parkinsoni-clay is the oldest known of the genus.

The *Planorbulinæ* comprise three species: 1. One near *Pl. ammonoides* ("*Nonionina oblonga*," "*N. Birmenstorfensis*," "*N. Badenensis*"), from the Macrocephalus-bed of the Lower Callovian; the Oxfordian of Birmenstorf, the Corallian of Geissberg, and the Kimmeridgian formation at Baden, Aargau: 2. *Pl. Siblingensis* from the Oxfordian Impressa-clays of Effing: and 3. *Pl. Moeschi* from the Astartian formation of the Kimmeridgian stage of Rödersdorf.

Mr. W. K. Parker, F.R.S., has kindly aided me in forming an opinion on several difficult points in the study of Dr. Kübler's descriptions and illustrations of these fossil Foraminifera of Switzerland.

NOTICES OF MEMOIRS.

DEVONSHIRE ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. Vol. V. Part I. 1872.

THIS volume contains a record of the proceedings which took place at the meeting held at Exeter, in July, 1872, with the Right Rev. the Lord Bishop of Exeter as President.

Mr. P. O. Hutchinson mentions the dredging of bones and teeth off Sidmouth, and the discovery of a tooth in the bed of the river Sid. He also contributes a note on Iron Pits, which were originally sunk for the purpose of seeking iron ore. In Devonshire they occur mostly on the hills capped by the Greensand formation, covered in places by a bed of plastic clay mixed with angular flints. The ore was procured on the hills, and the reducing process no doubt carried on in the valleys, for he notices the occurrence of numerous pieces of scoria in the parish of Uffculme, indicating that there had been a smelting place not far off. At Church Stanton, in the Blackdown Hills, there are the remains of several smelting places, indicated by scoriæ and slag.

Mr. R. N. Worth describes the rocks in the neighbourhood of Plymouth.

Mr. T. M. Hall points out records of tide, rain, and wind, during the Carboniferous Period in North Devon, in the shape of ripple-marks, and the imprints of rain-drops. Some little depressions which occurred in great numbers, and over more than twenty distinct surfaces in close proximity to each other, sometimes separated by a number of intermediate layers of smooth slate, he attributed to showers of drifting sand, the finer particles of which, borne upon the wind, had fallen upon soft mud. This idea was strongly supported by the occasional existence in some of the depressions of a small gritty nucleus, more or less angular in its character, and considerably harder than the matrix in which it was imbedded.

Mr. George Pycroft describes probable Glacial deposits in the valleys of Dawlish and Ashcombe, South Devon.

Mr. Pengelly furnishes some notes on the *Machairodus latidens* found by the Rev. J. MacEnery in Kent's Cavern, Torquay. He concludes that there is no reason whatever for believing that more than five canines and one incisor were found by Mr. MacEnery; and that the species belonged to the era of the Cave-earth of Kent's Cavern. There is, at present, no evidence that it belonged to the earlier period represented by the "Breccia"; and Mr. Pengelly adds, that should such evidence present itself hereafter, it will simply prove that, like the Cave Bear, *Machairodus* belonged to both periods.

Mr. Pengelly gives an account of the Literature of the Oreston Caverns, near Plymouth, and also a list of the mammalian remains found in them.

Mr. Whitaker furnishes a Supplementary List of Works on the

Geology, Mineralogy, and Palæontology of Devonshire, comprising one hundred and fifteen titles.

We have referred only to the geological papers. Many others there are on Natural History, Meteorology, Archæology, etc., and also a very elaborate report by Mr. Pengelly on the Signs of the Hotels, Taverns, Inns, Wine and Spirit Vaults and Beershops in Devonshire. H. B. W.

REVIEWS.

I.—The Depths of the Sea. An Account of the General Results of the Dredging Cruises of H.M. S.S. "Porcupine" and "Lightning," during the Summers of 1868, 1869, and 1870, under the scientific direction of Dr. Carpenter, F.R.S., J. Gwyn Jeffreys, F.R.S., and Dr. Wyville Thomson, F.R.S. By C. Wyville Thomson, LL.D., F.R.SS. L. & E., Regius Professor of Natural History in the University of Edinburgh. With numerous Illustrations and Maps. Royal 8vo. pp. 528. (London, 1873: Macmillan & Co.)

EVER since those early days of modern Natural History when the youthful and ardent Professor Edward Forbes first commenced the systematic study of the marine zoology of our islands, British Naturalists have been among the foremost to carry on the task of working out the distribution of life in the sea, not only around our own shores, but along many foreign coasts. The names of Darwin, MacAndrew, Barlee, Carpenter, Gwyn Jeffreys, William Thompson, Robert Ball, Captain Spratt, Woodward, Barrett, Godwin-Austen, and that of the author of the present volume, besides those of many other eminent Naturalists, may be cited, who have pursued this same line of research.

One of the general conclusions arrived at by Prof. Forbes, Sars, Audouin, and Milne-Edwards was that the sea-bed is divided into four principal regions, namely:—1. The Littoral zone or tract between tide-marks. 2. The Laminarian zone, from low water to 15 fathoms. 3. The Coralline zone, from 15 to 50 fathoms. 4. The deep-sea Coral-zone, from 50 to 100 fathoms or more.

The greatest depth attained by MacAndrew in dredging off the coast of Norway, appears to have been about 200 fathoms, and by Forbes in the Ægean, about 230 fathoms for living shells, and 250 fathoms for dead shells.

But, owing partly to the great difficulties attending deep-sea dredging, and partly to a settled conviction that beyond a depth of 300 fathoms animal life was an impossibility on account of the enormous pressure of such a column of water, the absence of light, food, etc., it became a generally accepted dogma that in the deeper abysses of the ocean, "life is either extinguished, or exhibits but a few sparks to mark its lingering presence." Yet even at this time evidence actually existed of life in the sea at a far greater depth than 300 fathoms. General Sir Edward Sabine, who was a member of Sir

John Ross's Arctic expedition in 1818, quite well recollects that whilst sounding in Baffin's Bay, in 1000 fathoms in mud, between one and two miles off shore, a magnificent *Asterias* (*Caput Medusæ*) was entangled by the line (see Woodcut, Fig. 1), whilst the soft greenish mud contained living specimens of *Lumbricus tubicola* (p. 19).

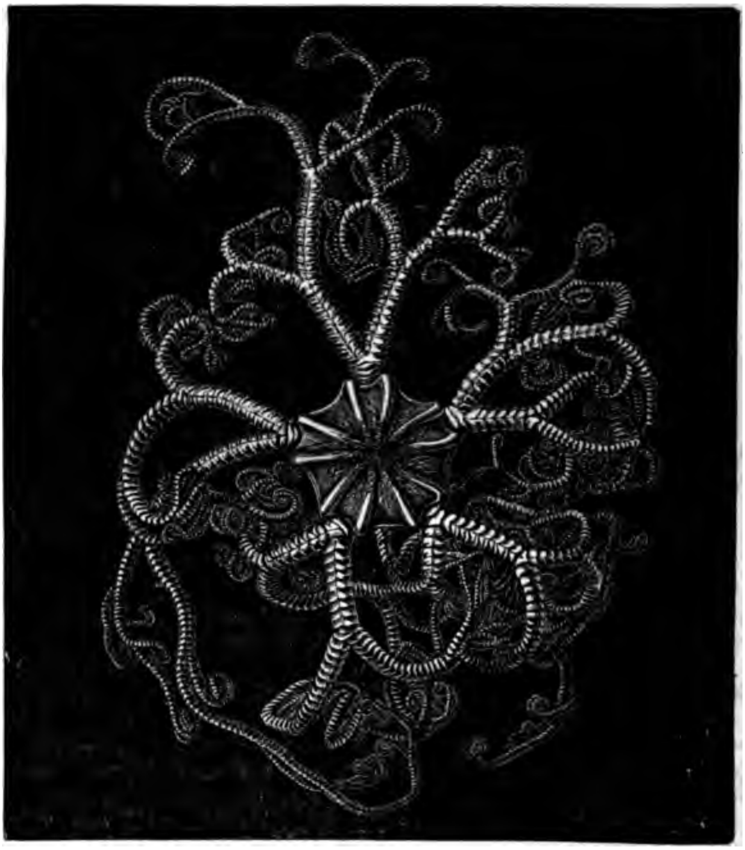

FIG. 1. *Asterophyton Linckii*, Muller and Troschel. A young specimen slightly enlarged. (From p. 19.)

"On the 28th June, 1845, Mr. Henry Goodsir, who was a member of Sir John Franklin's ill-fated expedition, obtained in Davis' Strait, from a depth of 300 fathoms, 'a capital haul—mollusca, crustacea, asteridea, spatangi, corallines, etc.' The bottom was composed of fine green mud, like that mentioned by Sir Edward Sabine." (p. 21.)

About 1854 Passed Midshipman Brooke, U.S.N., invented his ingenious sounding instrument for bringing up samples from the bottom. It only brought up a small quantity in a quill, but coming from a depth of over 1000 fathoms, it was of course an object of no small interest. Its examination resulted in the discovery that all over the Atlantic Basin the sediment consisted almost entirely of the calcareous shells of one species of Foraminifera, *Globigerina bulloides.*

The cruise of H.M.S. "Bulldog," under Captain Sir Leopold McClintock, in 1860, carries us on another step forward. During this expedition specimens of the bottom were brought up from depths of from 600 to 2000 fathoms, when, besides *Globigerina* mud, Dr. Wallick obtained 13 starfishes from 1260 fathoms.

The laying of telegraphic cables, and the soundings taken for that purpose in the Atlantic, the Mediterranean, and elsewhere, together with the various operations connected with the maintenance of sub-marine telegraphy, has added numerous most important facts and data concerning the fauna of the deep sea.

But it remained for Prof. Wyville Thomson and his colleagues, Dr. Carpenter and Mr. Gwyn Jeffreys, to collect and publish the first most complete and irrefragable array of evidence upon the conditions of life in the depths of the sea.

"During the several cruises of H.M. ships 'Lightning' and 'Porcupine,' in the years 1868, 1869, and 1870, fifty-seven hauls of the dredge were taken in the Atlantic at depths beyond 500 fathoms, and sixteen at depths beyond 1000 fathoms, and in all cases life was abundant. In 1869 we took two casts in depths greater than 2000 fathoms. In both of these life was abundant; and with the deepest cast, 2435 fathoms, off the mouth of the Bay of Biscay, we took living, well-marked, and characteristic examples of all the five invertebrate sub-kingdoms. And thus the question of the existence of abundant animal life at the bottom of the sea has been finally settled and for all depths, for there is no reason to suppose that the depth anywhere exceeds between three and four thousand fathoms: and if there be nothing in the conditions of a depth of 2500 fathoms to prevent the full development of a varied fauna, it is impossible to suppose that even an additional thousand fathoms would make any great difference." (p. 31.)

The book before us presents us with a full and most interesting account of these several cruises, and although the narrative is from the pen of Prof. Wyville Thomson himself, yet all the important points established by his colleagues, together with the Natural History results as worked out by the Rev. A. Merle Norman, Prof. Kölliker, Dr. Carter, Dr. Allman, Prof. Martin Duncan, and Dr. M'Intosh, will be found embodied in the text, which is most charmingly illustrated with figures of all the most important among the many new and rare forms of animals obtained, together with coloured maps and charts of the areas dredged over and the apparatus used. Let us now briefly note some of the dredgings.

Here is an account of a wonderful new living Echinoderm, closely related to one from the English Chalk.

"As the dredge was coming in we got a glimpse from time to time of a large scarlet urchin in the bag. We thought it was one of the highly-coloured forms of *Echinus Flemingii* of unusual size, and as it was blowing fresh, and there was some little difficulty in getting the dredge capsized, we gave little heed to what seemed to be an inevitable necessity—that it should be crushed to pieces. We were somewhat surprised, therefore, when it rolled out of the bag uninjured; and our surprise increased, and was certainly, in my case, mingled with a certain amount of nervousness, when it settled down quietly in the form of a round red cake, and began to pant—a line of conduct, to say the least of it, very unusual in its rigid, undemonstrative order. Yet there it was, with all the ordinary characters of a sea-urchin, its inter-ambulacral areas, and its ambulacral areas with their rows of tube feet, its spines, and five sharp blue teeth; and curious undulations were passing through its perfectly flexible leather-like tests. I had to summon up some resolution before taking the weird little monster in my hand, and congratulating myself on the most interesting addition to my favourite family which had been made for many a day. (See Figs. 2 and 3.)

"I have named this genus *Calveria hystrix*, after our excellent commander, Captain Calver, and his tidy little vessel, the 'Porcupine,' in grateful commemoration of the pleasant times we had together.

"In the summer of 1870 Mr. Gwyn Jeffreys, dredging on the coast of Portugal, took two nearly perfect specimens and several fragments of another species of the genus *Calveria;* and subsequent careful examination of fragments and *débris* has shown that this second species, *C. fenestrata,* occurs likewise in the deep water off the coast of Scotland and Ireland." (p. 159.)

"*Phormosoma placenta* resembles *Calveria* in having a peristome flexible, the plates overlapping in the same way, and in the same directions; but the plates overlap one another only slightly, and they leave no membranous spaces between, so that they form a continuous shell. The great peculiarity of this form is that the upper surface is quite different from the lower." (p. 161.)

"We have thus become acquainted with *three* members of a family of urchins which, while differing in a most marked way from all other known living groups, bear a certain relation to some of these, and easily fall into their place in urchin classification. They are 'regular Echinids,' and have the normal number and arrangement of the principal parts. They resemble the *Cidaridæ* in the continuation of the lines of ambulacral pores over the scaly membrane of the peristome to the mouth, and they approach the *Diadematidæ* in their hollow spines, in the form of their small pedicellariæ, and in the general structure of the jaw pyramid. From both of these families they differ in the imbricated arrangement of the plates, and in the structure of the pore-area, to the widest extent compatible with belonging to the same sub-order.

"Many years ago Mr. Wickham Flower, of Park Hill, Croydon, procured a very curious fossil from the Upper Chalk of Higham, near Rochester. It consisted of a number of series of imbricated plates radiating from a centre, and while certain sets of these plates were perforated with the characteristic double pores of the urchins, these were absent in alternate series. Some points about this fossil,

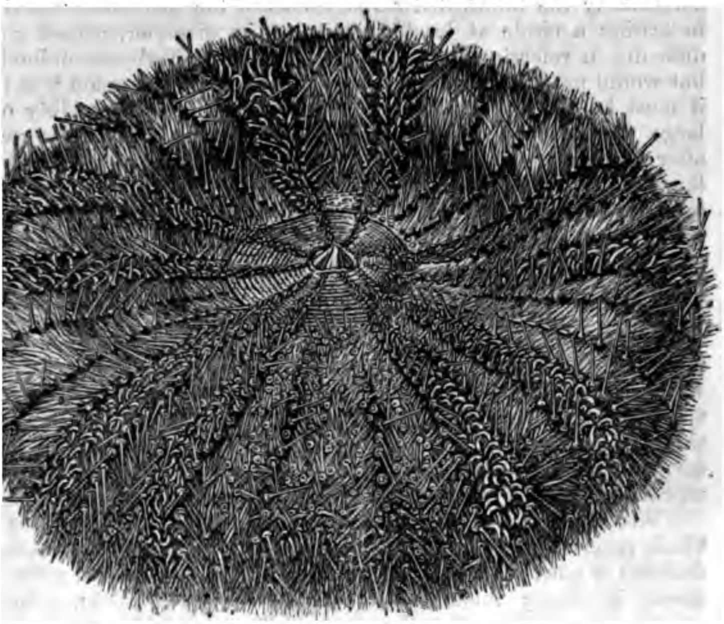

FIG. 2. *Calveria hystrix.* Wyville Thomson, two-thirds the natural size.
(From p. 156, fig. 27.)

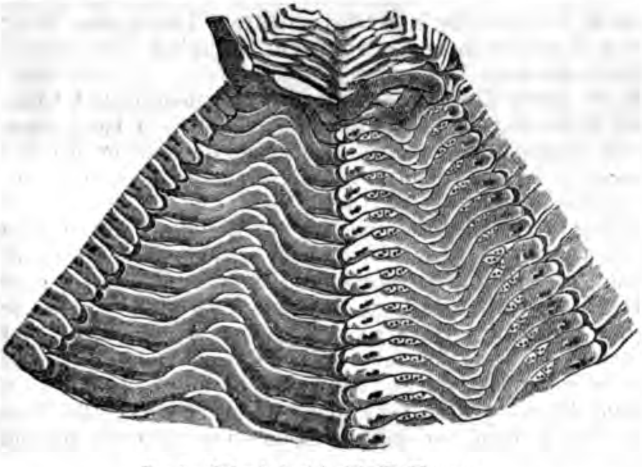

FIG. 3. *Calveria hystrix,* Wyville Thomson.
Inner surface of a portion of the test showing the structure of the ambulacral and inter-ambulacral areas. (From p. 157, fig. 28.)

particularly the imbricated arrangement of the plates over portions indicating a circle at least four inches in diameter, caused great difficulty in referring it to its place. Edward Forbes examined it, but would not hazard an opinion. The general impression was that it must be the scaly peristome of some large urchin, possibly of a large *Cyphosoma*, a genus abundant in the same bed. Some years after the discovery of the first specimen, a second was obtained by the Rev. Norman Glass, from Charlton, in Kent. This specimen appeared at first to solve the difficulty, for it contained in the centre a well-developed 'lantern of Aristotle'; there then was the peristome of the urchin of which Mr. Flower's specimen was the periproct. The late Dr. S. P. Woodward examined the two specimens carefully, and found that the question was not so easily settled. He detected the curious reversal of the imbrication of the plates in the ambulacral and inter-ambulacral area described in *Calveria*, and at one point he traced the plates over the edge of the specimen, and found that they were repeated inverted on the other side. With great patience and great sagacity he worked the thing out, and came to the conclusion that he was dealing with the representative of a lost family of regular echinids.

"Woodward names his new genus *Echinothuria*, and describes the Chalk species, *E. floris*, almost as fully and accurately as we could describe it now, with a full knowledge of its relations—for *Echinothuria* is closely related to *Calveria* and *Phormosoma*. In all essential family characters they agree. The plates imbricated in the same directions and on the same plan, and the structure of the ambulacral area, which is so special and characteristic, is the same. *Echinothuria* differs from *Calveria* in the wider inter-ambulacral and ambulacral plates, in the smaller amount of overlapping, and in the absence of membranous intervals; and from *Phormosoma* it differs in having the structure and ornament of the apical and oral surfaces of the tests the same.

"As the genus *Echinothuria* was the first described, I have felt justified in naming the family the *Echinothuridæ*. I have done this with the greater pleasure, as it brings into prominence a term suggested by my late friend Dr. Woodward, whose early death was a serious loss to science." (p. 164.)

Speaking of the Lily-Encrinites, Prof. Wyville Thomson says:—Both on account of their beauty and extreme rarity, and of the important part they have borne in the fauna of some of the past periods of the earth's history, the first order of the Echinoderms, Crinoidea, has always had a special interest to naturalists; and, on the watch as we were for missing links which might connect the present with the past, we eagerly welcomed any indication of their presence. Crinoids were very abundant in the seas of the Silurian period; deep beds of Carboniferous Limestone are often formed by the accumulation of little else than their skeletons, the stem joints and cups cemented together by limy sediment; and dozens of the perfect crowns of the elegant Lily-Encrinite are often scattered over the surface of slabs of the Muschelkalk. But during the lapse of ages, the whole order seems to have been worsted in the 'struggle for life.' They become scarce in the newer Mesozoic beds, still scarcer in the Tertiaries, and up to within the last few years only two living stalked Crinoids were known in the seas of the present period, and these appeared to be confined to deep water in the seas of the Antilles, whence fishermen from time to time bring up mutilated specimens on their lines. Their existence has been known for more than a century; but, although many eyes have been watching for them, until very lately not more than twenty specimens had reached Europe, and of those only two showed all the joints and plates of the skeleton, and the soft parts were lost in all.

"These two species belong to the genus *Pentacrinus*, which is well represented in the beds of the Lias and Oolite, and sparingly in the white Chalk, and are named respectively *Pentacrinus asteria*, L., and *P. Mülleri*, Oersted. Fig. 4 represents the first of these. This species has been known in Europe since the year 1755, when a specimen was brought to Paris from the Island of Martinique, and described by Guettard in the Memoirs of the Royal Academy of Sciences.

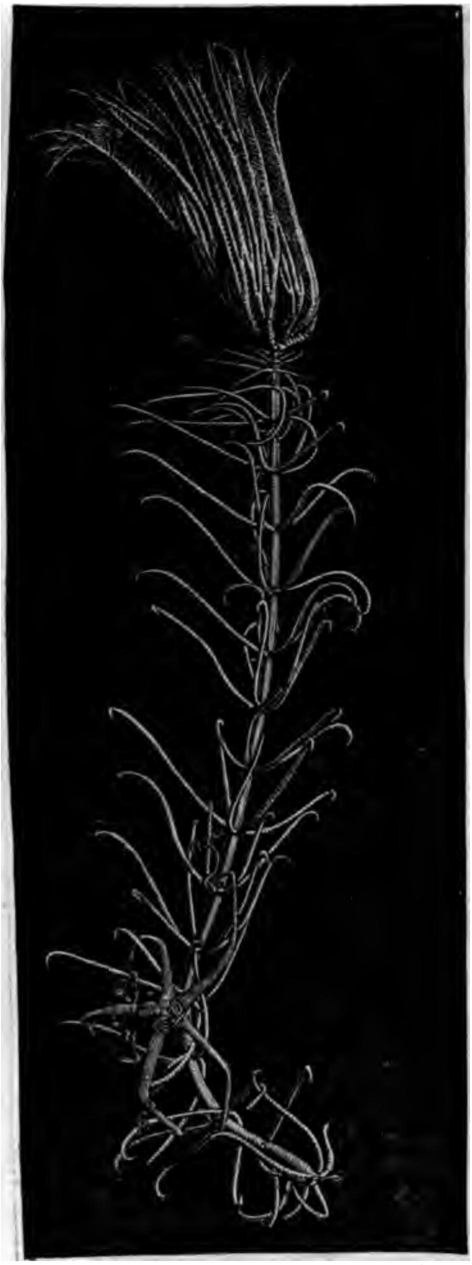

Fig. 4. ***Pentacrinus asteria*, Linnæus, one-fourth the natural size. (From fig. 70, p. 436.)**

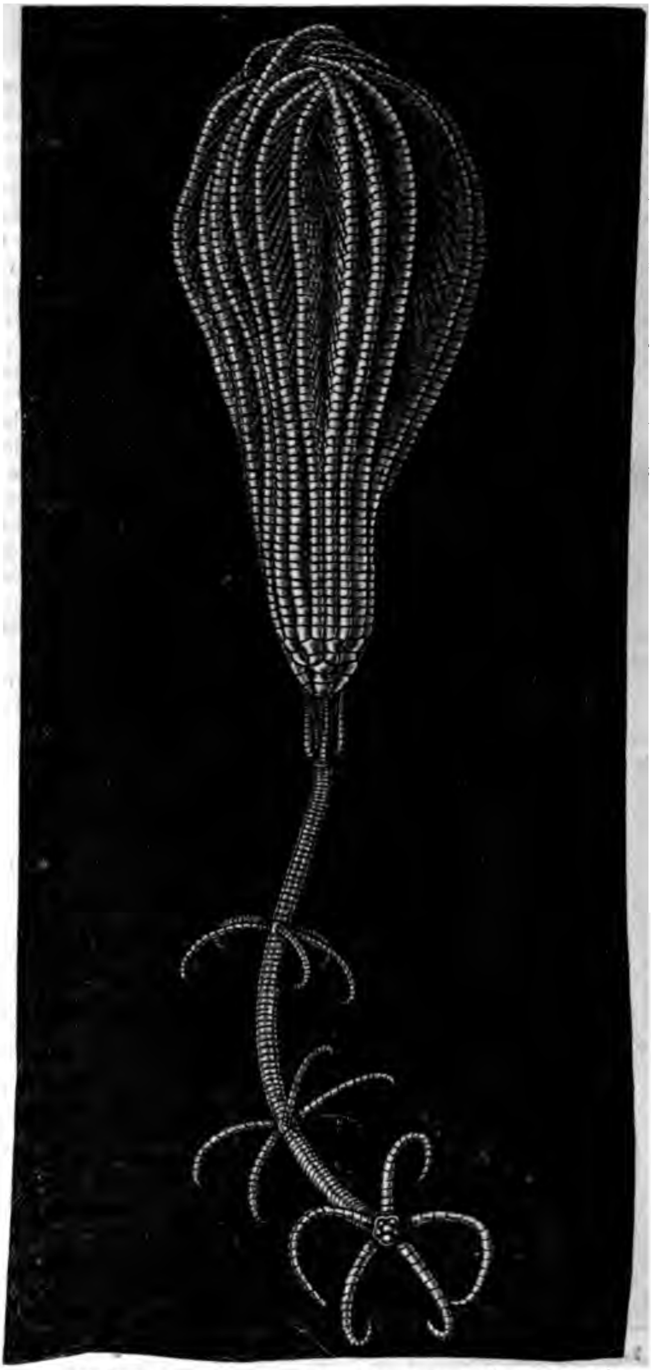

Fig. 5. Pentacrinus Wyville-thomsoni, Jeffreys (Natural size). (From fig. 71, p. 443.)

For the next hundred years an example turned up now and then from the Antilles. Ellis described one now in the Hunterian Museum in Glasgow University, in the Philosophical Transactions for 1761. One or two found their way into the museums of Copenhagen, Bristol, and Paris; two into the British Museum, and one fortunately fell into the hands of the late Prof. Johannes Müller, of Berlin, who published an elaborate account of it in the Transactions of the Royal Berlin Academy for 1843. Within the last few years Mr. Damon, of Weymouth, a well-known collector of natural history objects, has procured several very good specimens, which are now lodged in the museums of Moscow, Melbourne, Liverpool, and London.

"On the 21st of July, 1870, Mr. Gwyn Jeffreys, dredging from the 'Porcupine' at a depth of 1095 fathoms, lat. 39° 42′ N., long. 90° 43′ W., with a bottom temperature of 4°·3 C., and a bottom of soft mud, took about 20 specimens of a handsome *Pentacrinus* involved in the 'hempen tangles' (attached to the lower end of the dredge-bag), and this splendid addition to the fauna of the European seas my friend has done me the honour to associate with my name. *Pentacrinus Wyville-thomsoni*, Jeffreys (Fig. 5), is intermediate in some of its characters between *P. asteria* and *P. Mülleri;* it approaches the latter species, however, the more nearly."

"All the stems of mature examples of this species end uniformly in a nodal joint, surrounded with its whorl of cirri, which curve downwards into a kind of grappling root. The lower surface of the terminal joint is in all smoothed and rounded, evidently by absorption, showing that the animal had for long been free. This character I have remarked as occurring in *P. Mülleri.* I have no doubt that it is constant in the present species, and that the animal lives loosely rooted in the soft mud, and can change its place at pleasure by swimming with its pennated arms; that it is in fact intermediate in this respect between the free genus *Antedon* and the permanently fixed Crinoids." (p. 444.)

"Two other fixed Crinoids were dredged from the 'Porcupine,' and these must be referred to the *Apiocrinidæ,* which differ from all other sections of the order in the structure of the upper part of the stem." (p. 446.)

"The Apiocrinidæ attained their maximum during the Jurassic period, when they were represented by many fine species of the genera *Apiocrinus* and *Millericrinus.* The Chalk genus *Bourgueticrinus* shows many symptoms of degeneracy. The head is small, and the arms are small and short. The arm-joints are so minute that it is scarcely possible to make up a series from the fragments scattered through the Chalk, in the neighbourhood of a cluster of heads. The stem, on the other hand, is disproportionately large and long, and one is led to suspect that the animal was nourished chiefly by the general surface absorption of organic manner, and that the head and special assimilative organs were principally concerned in the function of reproduction. *Rhizocrinus loffotensis,* M. Sars, was discovered in the year 1864, at a depth of about 300 fathoms, off the Loffoten Islands, by G. O. Sars, a son of the celebrated Professor of

Natural History in the University of Christiania, by whom it was described in the year 1868. It is obviously a form of the Apiocrinidæ still more degraded than *Bourgueticrinus*, which it closely resembles." (p. 447.)

We must now close this very brief notice of Prof. Wyville Thomson's beautiful book, so full of interest for the Naturalist, and so rich in palæontological materials, to which we may again be drawn to allude in a future number.

The book gives us the best and fullest notion we have yet had laid before us of the vast benefit conferred on science by the wise action of the Council of the Royal Society, in pressing the importance of such work upon the Government, so that they have gone on from the smaller cruises of the "Porcupine" and "Lightning," to the grander idea of despatching "an expedition to traverse the great ocean basins, and take an outline survey of the vast new field of research—the bottom of the sea." Speed, speed, the "Challenger!" and success to all on board!

II.—THE HIGHER MINISTRY OF NATURE VIEWED IN THE LIGHT OF MODERN SCIENCE, ETC. By JOHN R. LEIFCHILD, A.M. 8vo. pp. 543. (London: Hodder & Stoughton, 1872.)

If the author of the book before us admits that he deals in many portions "with inevitable and insuperable difficulties," touching "upon the extreme limits of human intelligence, where no thinker can hope for clear solution, in the present state of our knowledge," it is easily to be conceived that the reviewer finds his task far from light.

"This world of ours," writes the author, in his Recapitulation, "and the universe so far as we know it, forms a magnificent manifestation to man, and perhaps to higher beings, of the creating and conserving Deity, without whose creation and conservation in perpetual exercise, the totality of existing things, organic and inorganic, which we call Nature, would not have come into, and would not continue, in existence.

"Every relation, or law, or method, we discern and discover in Nature, and in ourselves, is an already accepted, or an additional proof of this fundamental position. The advances and adjustments of scientific research, all, when rightly interpreted, contribute to strengthen and enlarge this view." (p. 539.)

Much of Mr. Leifchild's book is necessarily occupied with matter beyond the limits of this Journal to discuss. We may therefore pass over many chapters—nay, must of necessity do so in a brief review—chapters entitled "The Fleeting and the Enduring"—"The Two Ministries of Nature"—"Ignorance, Definitions," etc.—"Theologies and Natural Science"—"The Great Problem and our Means of Solving it"—"The Argument from Design."

Under this last chapter-heading we notice in passing the good sense of the author in deprecating the popular defect of treating certain phenomena, certain structures or provisions, as specially evidencing Divine skill, goodness or forethought, more so than a multitude of others which we either do not know or do not enumerate. On this account all such titles as the "Wonders" or the "Marvels of Nature," or the "Footprints of the Creator," are inappropriate and misleading. The whole of Nature may be called marvellous (p. 97).

Here Paley shines forth:—"A common spectator of a grand building would most admire the ornamental decorations, the sculptured capitals, the enriched cornices, and the scrolls (wreaths?) of foliage exhibited before him, but the more cultured student would rather observe and commend the total design, the noble plan, the combination of parts, and the impressive grandeur of the whole building. In these he would discern the master-mind, and while particular details would receive his attention in due course, he would derive his impressions from and pronounce his approbation of the entire structure. The subordination of the smallest details to the one all-embracing and grand conception of the skilful designer and executor of the building would elicit his admiration, and elevate his conception to a higher thinking-point than even the most perfect construction and finish of particular parts. So would it be with our contemplation of the grand Temple of Nature, could we behold it as a perfect whole." (p. 99.)

"Function and purpose in structure" is next touched upon, and Sir Charles Bell and Mr. Murphy are quoted at some length.

We are rather surprised at the author's next topic. He says:—"When we begin to inquire respecting Ultimate Purpose, that is, purpose beyond the present apparent order and constitution of things, Natural Science fails to give a reply. We may show, for instance, how coal and metals have been stored and arranged conveniently for the use of man; but having arrived at human advantage, we can proceed no further by any natural knowledge. Dynamical laws, modes of formation and cosmical arrangements and present benefits can be discovered and unfolded; and this is the province of Science. In considering the entire inorganic world, Science cannot inform us in any degree as to the ultimate purpose of such a world. Nor can Science do much more even in the organic world. At the best, physiology shows to us the function of structures in their mutual relations of parts to the complete organism. There, however, it pauses. Ultimate purpose is quite beyond its province." (p. 105.) "Science," says the author, "is essential at the threshold as giving us the proper means of inquiry, and as affording us the basis of reasoning. Having, however, enabled us to lay the foundation, it has done its utmost, and must leave any superstructure to other hands. At this stage the Higher Ministry of Nature may be brought into exercise, and by its aid we may erect a superstructure upon the scientific foundation." (p. 106.)

Here, as it seems to us, our author leaves "*the solid ground of Nature*"; and when he urges that "we may speculate from the known to the unknown, and the conditions of the former being ascertained, we may warrantably conjecture some of the conditions of the unknown," we feel that we are beyond our depth, and not having confidence in the author's philosophy, we strike for the shore.

Under the head of "Definition of Species," the author gives us a carefully collected summary of all the leading opinions of what is meant by the term *Species* in Natural History (p. 200); indeed the book throughout is stored with extracts from Darwin, Lyell, Herbert Spencer, Wallace, Mill, and very many other writers, evidencing the wide extent of the author's reading.

There are many of the author's conclusions however which we cannot accept; and some of his assertions are hardly correct. For instance, under the head of "Objection to Darwin's Theory," is the following statement (p. 209):—

"A very formidable objection against Darwinism is that a vast number of *transitional forms* should be apparent as the necessary consequence of the gradual passage of one species into another. Any reader will perceive on reflection that an universal and continuous development of organic beings through a long series of forms, must, if it has been in actual operation, disclose numerous mutations at its various stages, of forms intermediate between two species. Otherwise the connecting links in the living chain would be wanting. Yet there neither is in the organic beings now known to be living on earth, nor in the remains of animals as yet exhumed, a single decided and incontrovertibly admitted instance of a transitional variety." (p. 210.) Again (p. 212), "And that there must have been many such intermediate creatures is manifest, if we look at the great differences between birds and all other vertebrate animals. So great are these that Mr. Darwin remarks, 'We may account for the distinctness of birds from all other vertebrate animals by the belief that many ancient forms of life have been utterly lost.'

"But where," continues our author, "could these lost forms have been, granting that they ever existed? They must have been intermediate, and must have borne organs in many intermediate and imperfect states; while any animal approaching to a bird, yet not a bird, any animal with a half-developed wing, together with or without other half-developed organs at the same time, must have been a monstrosity, and either in respect of easy motion on the ground or any motion in the air, an inconvenient and painfully existing monstrosity. A creature between any known vertebrate animal and any known bird, in many and perhaps every preceding stage of development, could not have moved without difficulty or failure; and such failure must, in most cases, if not in all, have prevented the perfection and completeness of the after-growth and structure. All such imperfections of structure must have been hindrances to freedom of action, and thereby to fulness of growth, and thereby again to success." (p. 213.)

In reply to the assertion of the general absence of all transitional forms, we will quote two very distinct authorities.

Prof. Owen, in his Comparative Anatomy of Vertebrates, has pointed *out that there is* a direct line of succession between the tridactyle Eocene

Palæotherium and the modern single-hoofed *Equus*, through *Paloplotherium*, *Anchitherium* and *Hipparion*. "Thus the succession in time accords with the gradational modifications by which *Palæotherium* is linked on to *Equus*." (Owen op. cit. p. 793.)

Prof. Huxley, in a lecture delivered before the Royal Institution of Great Britain on Feb. 7, 1868, pointed out the close affinities existing between the *Dinosauria* and Birds. The recent discovery by Prof. O. C. Marsh, of Yale College, Ct., U.S.A., of a remarkable extinct bird with biconcave vertebræ and well-developed teeth in both jaws, adds another link to the remarkable fossil bird from Solenhofen, the *Archæopteryx lithographica*, and sufficiently proves the justness of Dr. Darwin's conclusion. Other evidence (we learn) will shortly be forthcoming in this country tending in the same direction.

Compact as is the Avian class, we have, even among living birds, many anomalous forms, such as the all-but-wingless Penguins, and the lately exterminated Auk, and Dodo. The Rhea and Ostrich have only rudimentary wings, the Cassowary and Apteryx none at all, nor had the gigantic birds of New Zealand a trace of wings, yet they managed to live on save for the interference of man upon the scene of their existence—notwithstanding Mr. Leifchild's condemnation of such wingless monstrosities.

It may be interesting to our readers, as well as to the author of "The Higher Ministry of Nature," to know that there is now living on the Continent of Australia a bipedal lizard,[1] which certainly goes a long way to meet a bird, with well-developed teeth, biconcave vertebræ, and a long rat-like tail!

To those who wish to follow the author "one step further," when he suggests "the probability of Angelic and Human Continuity," we leave the perusal of this singular volume. There can be no doubt of the earnestness and sincerity of the author, but, like all earnest advocates, he is not altogether impartial; for whilst, on the one hand, he charges Darwin with gathering a vast *army of facts* or phenomena, and drilling them during many years upon one system, he has collected an equally extensive *series of extracts* from ancient and modern writers, and presses them in favour of his own peculiar tenets with all the logic he can command. Mr. Leifchild is an apt illustration of the old adage, "Logically demonstrate your case, and I will undertake to prove by logic that the very reverse of what you have stated is the truth."

III.—SKETCH OF A NEW GEOLOGICAL MAP OF VICTORIA. By R. BROUGH SMYTH, F.G.S., etc., Secretary for Mines for the Colony of Victoria.

WE have lately had forwarded to us the above publication from the Government Mining Department of the Colony of Victoria. The sketch is in the form of a lithograph, printed in colours, on the scale of one inch to ten miles, and is intended to accompany the Official Catalogue of the Victorian Court in the London Exhibition of the present year. The map furnishes us with the latest information and opinions held by the authorities of the Victorian Mining Department on Victorian Geology. The geological features are chiefly taken from Mr. Selwyn's Sketch Map, published by the late Geological Survey of Victoria, with additions by Mr. Brough Smyth and certain of the Mining Surveyors under his direction. The basis of the topographical portion of Mr. Smyth's New Geological Sketch Map was a compilation made at the Office of Mines in 1866, from recent surveys, and in this respect has a considerable advantage over Mr. Selwyn's earlier one.

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[1] "The great Frilled Lizard." *Chlamydosaurus Kingii.* This lizard *habitually* runs about on its *hind-legs*, seldom or never touching the ground with its fore-paws, which are but little developed.

In certain essential points the present map differs from that of Mr. Selwyn. Should these additions eventually prove to be correct, the value of the map will be considerably increased, as they refer to rock masses generally yielding economic minerals of considerable value.

In the large eastern province of the Colony, Gippsland, much alteration has been made in the relative boundaries of the Crystalline rocks and the Upper and Lower Silurians. This, as this wild and hilly portion of the country becomes opened up and better known, is nothing more than might have been expected. A more clear and well defined line has also been drawn between the Upper and Lower Silurian deposits in the central portions of the Colony.

The remaining rocks of Palæozoic age were formerly delineated on Mr. Selwyn's Map by one colour, and called in a general way "Upper Palæozoic." The upper portion of this series at certain localities contains the remains of *Lepidodendra* (Mount Tambo, Mansfield, Avon River, etc.), and it was thought extremely probable that these might represent some portion of the European Carboniferous Series. Certain small patches of fossiliferous limestone in Eastern Gippsland (Buchan, Bindi, etc.), regarding the identity of which some doubts were entertained, are now mapped by Mr. Smyth as Devonian, apparently on the strength of certain fossils, some of which were pronounced by Professor McCoy to be identical with species from the Devonian of the Eifel. Those mentioned by Mr. Smyth in the explanation of the Sketch Map are *Spirifera lævicostata*, the remains of Placodermatous Fish, and Corals. The upper portion of the series before mentioned as containing *Lepidodendra* are now definitely coloured as Carboniferous.

The boundaries of the Carbonaceous Secondary beds, in places coal-bearing, occupying some portion of the southern sea-board, have not undergone any very considerable change since they were first laid down by Mr. Selwyn.

A series of beds on the east side of Port Philip Bay, much resembling in their lithological aspect our Lower Tertiaries, and formerly provisionally called Eocene, are on this Map termed '*Oligocene*.' They are well seen at Mounts Eliza and Martha, and at Schnapper Point, where the following fossils appear very characteristic:—*Voluta anticingulata*, McCoy; *V. antiscallaris*, McCoy; *V. Hannafordi*, M'Coy; *V. strophodon*, McCoy; *Cypræa gastroplax*, McCoy; *Trivia avallanoides*, McCoy; *T. australis*, McCoy, and many others.

In the present unsatisfactory state of our knowledge regarding the Australian Tertiary series, it would perhaps be well if Victorian geologists would adopt a suggestion of Prof. Martin Duncan's (On the Fossil Corals of the Australian Tertiary Deposits, Quart. Journ. Geol. Soc., vol. xxvi., p. 288), that instead of subdividing their Tertiary series, whilst so little is known about them, into Pliocene, Miocene, and Eocene, or Oligocene, as the case may be, they should content themselves for the present with merely calling them all Cainozoic.

The artistic portion of Mr. Smyth's Sketch Map is everything that could be desired; the type is clear and good, and the colours evenly and correctly laid on. We shall be glad to see further geological efforts on the part of the Victorian Mining Department, but should advise them to pay a little more attention to palæontological nomenclature than is evinced in the few names of fossils given in the letter-press description of the Map in the Essay attached to the Exhibition Catalogue. R. E.

IV.—A MONOGRAPH OF THE BRITISH GRAPTOLITIDÆ. By Prof. H. A. NICHOLSON, M.D., D.Sc., M.A., etc. Part I. (Edinburgh: Blackwood & Sons. 1872.)

WITHIN the last few years much has been added to our knowledge of the peculiar group of fossils which form the subject of the present Monograph. Since 1866, when Prof. Nicholson commenced his labours on the group, the British Graptolites have been treated of in five-and-twenty memoirs, and the number of species known to Britain has been at least doubled. This result is mainly due to the researches of Prof. Nicholson in the Skiddaw Slates and Coniston Flags of the English Lake-district, and in the Moffat group of the south of Scotland, and it is upon the extensive collection which he has made from these richly graptoliferous rocks that the present work is chiefly based.

The first and only part as yet published "is intended to serve as an Introduction to the study of the Graptolitidæ generally."

The first chapter is devoted to the bibliography of the group, and comprises a chronological history from 1727, when Bromel, in describing the fossils of Sweden, evidently mistakes graptolites for leaves of grasses, to 1871, when the discovery of a British specimen with gonothecæ finally settled the much-debated question of the zoological position of these interesting fossils, showing that they were truly referable to the Hydrozoa, and nearly related to the Sertularians and Plumularians, as first suggested by Portlock in 1843.

In chapter ii. the "general form of Graptolites," their mode of preservation, and the sediments in which they occur, are successively treated of. Under the first heading the terminology employed is explained. It is to be regretted that the author still adheres to the terms "frond" and "stipe." The former is certainly not a suitable term for the entire exo-skeleton of an animal, nor is the latter for its component parts, or as it is here expressed, "the separate simple elements which make up the complex species."

The next two chapters are devoted to the general and special morphology of graptolites. In order to explain their general structure, three well-known species are selected for description as typical forms of the family, and the various aspects each may present according to the mode of preservation, and the view exhibited, whether lateral, dorsal, or ventral, are clearly pointed out. This last aspect, to which our author does not assign a name, is that which gives rise to what are called "scalariform" impressions. The original *Graptolithus scalaris* of Linnæus is generally believed to have been founded on an impression of this nature, whence the name.

The structure of the various organs of which the graptolite is composed is then described in detail, and the modifications they undergo in the different genera are fully explained; and this subject is further pursued in the following chapter, which treats of the "nature and functions of the base." We do not see how the term *base* is reconcilable with the view held by Prof. Nicholson, and ably advocated in this chapter, that the "radiculate" graptolites were free-swimming organisms. If they were so, we have no right to assume that the proximal end of the polypary was invariably lowermost; and even then the term would scarcely be appropriate. With the "dendroid" graptolites the case is different, for, since the publication of the work under review, the inference that these forms "may have been attached to the sea-bottom or to some objects during their growth," which Hall drew from their "general form, and from their analogy with other bodies," has been confirmed by the discovery of a British specimen with a process of attachment similar to the hydrorhiza of the recent Sertularian zoophytes.

The sixth chapter treats of "reproduction and development." Only two specimens with organs undoubtedly forming a portion of the reproductive system are known to have been found. One of these was described and figured by Hall in 1858; the other by Hopkinson in 1871. The nature of the peculiar bodies described by Nicholson in 1866 as "grapto-gonophores" has not yet been satisfactorily determined; and though still advocating the opinion then expressed, the author admits that he has no fresh evidence of their connexion with graptolites to bring forward. If his conclusion that these bodies "possessed in their free condition the power of independent growth" is correct, they bear no real analogy to the gonothecæ of the Sertularian zoophytes. To these gonothecæ the persistent capsules found by Hall and Hopkinson on *Diplograptus Whitfieldi* and *D. pristis* respectively, bear a most striking resemblance, and being external processes, show that graptolites are truly Hydrozoa, and not Polyzoa.

This question is treated of in the succeeding chapter, in which the author, after briefly stating his views on the mode of existence of the radiculate and dendroid graptolites, notices the affinities they present to the Actinozoa, the Hydrozoa, and the Polyzoa. We believe that with the exception of Richter, all recent authorities consider the graptolites to be Hydrozoa; and Allman has shown the *inconclusiveness* of the arguments in favour of the Polyzoan ities of the graptolites put forward in Richter's last paper on subject (1871). But whether the true graptolites, the Rhabdo-:a of Allman, should form a distinct order of the class Hydrozoa, sub-order of the order Hydroida, still remains for determina-. In this memoir they are considered to form a distinct order, ıther "sub-class" of the Hydrozoa, and under the name *Grapto-æ* are grouped together the Rhabdophora, the Dendroidea, and w genera of doubtful affinity.

he next chapter comprises a brief summary of the present state ur knowledge of the geological distribution of the Graptolites their allies. The author divides the Silurian epoch, to which e fossils are almost exclusively confined, into three distinct ɔds:—1. The Skiddaw and Quebec period. 2. The Llandeilo Caradoc period. 3. The Upper Silurian period. If we include Lower Llandeilo or Arenig group in the first period (its proper e), and eliminate from this period the species *Dicranograptus ɔsus*, which really begins in the true Llandeilo and not in the ɔig rocks, we shall find that out of the ninety British species enumerated, but three pass from the Skiddaw and Quebec, or ıig period, to the Llandeilo and Caradoc period. From the 'er to the Upper Silurian rocks the well-known species *Grapto-ıs priodon* and *G. colonus* alone pass.

ecent researches tend to show that the Rhabdophora are even e restricted in their range in time than appears from the table n in this chapter. We refer especially to the researches of worth in the Lower Silurian rocks of the south of Scotland. Dendroidea, on the other hand, will probably ultimately be ıd to have a more extensive range than hitherto supposed.

ı the ninth and concluding chapter the genera of the Grapto-æ are described. They are grouped into five "sections," named ectively, Monoprionidæ, Diprionidæ, Tetraprionidæ, Dendroidea, Incertæ Sedis. The sequence in which the genera of the ıoprionidæ are described shows that the author does not clearly prehend the affinities of the different forms; and from the sup-sion of the genus *Dicellograptus*, which constitutes with *Dicrano-ıtus* the section or family Monodiprionidæ, it would appear that ıas failed to recognize the primitive morphological types upon ɔh the several generic forms are constructed.

he few defects we have endeavoured to point out are of slight ıequence compared to the large amount of valuable matter which ere brought before us. The present part of Prof. Nicholson's ıograph forms a complete introduction to the study of the British ɔtolites, and being written in the free though concise style ɔh characterizes all the author's works, being admirably printed, profusely illustrated with well-executed woodcuts, will be with pleasure by all who take an interest in Silurian ɔontology. It is undoubtedly the most important memoir on graptolites which has appeared since the publication of Mr. 'uthers's Enumeration of the British Species (Geol. Mag., Vol. 1868), and when completed will, we doubt not, fully equal, ot surpass, *Prof. Hall's* splendid Monograph on the Graptolites *he Quebec Group.*

J. H.

V.—GEOLOGICAL STORIES: A SERIES OF AUTOBIOGRAPHIES IN CHRONOLOGICAL ORDER. By J. E. TAYLOR, F.G.S. 8vo. pp. 301. (London: Robert Hardwicke. 1873.)

POPULAR books written to excite an interest in Geology are not wanting, and certainly there is a great choice for the beginner. If he want an elementary and purely scientific work, he can take Lyell's "Student's Manual," or Phillips' "Guide," Jukes' "School Manual" (the Jukes-Brown edition), or Portlock and Tate, Ramsay's "Physical Geography and Geology," or Ward's "Elementary Geology," Page's "Introductory Text-book," or his "Earth's Crust." These and others might be cited, which would any of them serve as a geological primer, although those of Lyell and Ramsay are works of reference at all times.

Of the more popularly written books, not intended as text-books, there have been many, and foremost amongst them are the writings of Hugh Miller, and his books will remain whilst a multitude of others are lost sight of. In this class we may place Kingsley's "Town Geology," which we noticed a short time ago, and also the volume before us, Taylor's "Geological Stories," as all have similar objects. Mr. Taylor's "Stories" originally appeared in "Science Gossip," and are now published, with the addition of many illustrations, which answer their purpose, though they are of very unequal merit. Each chapter contains the history of a series of rocks, written in the style of an autobiography. Thus, in the first, *The Story of a Piece of Granite,* the Granite is made to tell its history and that of other metamorphic and igneous rocks. *Quartz* tells a tale of the oldest stratified rocks, the Laurentian; and *Slate* speaks about the Cambrian epoch. *Limestone* treats of the Silurian rocks, and *Sandstone* of the Old Red Sandstone and Devonian rocks. *A Piece of Coal* explains its own origin, and that of the other Carboniferous rocks. *Rock-salt* relates how it was formed in a sort of "Dead Sea," and makes some observations on the Permian beds, as well as the Trias.

A Piece of Jet, like the others, gives a poetical prologue, and of course tells about the "countless snakes" turned to stone in the Lias. *Purbeck Marble* gives us an account of the Oolitic rocks, and *A Piece of Chalk* of the Cretaceous period. *A Lump of Clay* tells of Eocene times, and *A Piece of Lignite* of the Miocene period. *The Crags* tell a story of Pliocene times, and *A Boulder* gives an account of the Glacial period. *A Gravel-pit* discusses the last changes and the appearance of man as evidenced by the flint-implements it has taken care of.

In conclusion Mr. Taylor gives a short retrospect or summary of geological events and a table of strata. The familiar style in which the book is written will no doubt be attractive to those who shrink from a more scientific volume. Such readers will obtain in it a very fair knowledge of geological history, and we only hope it may stimulate them to push on their inquiries, and read one or other of the elementary text-books we have before cited.

REPORTS AND PROCEEDINGS.

Geological Society of London.—I.—March 12, 1873.—Joseph Prestwich, Esq., F.R.S., Vice-President, in the Chair.—The following communications were read:—
1. "Note on some Brachiopoda collected by Mr. Judd from the Jurassic Deposits of the East Coast of Scotland." By Thomas Davidson, Esq., F.R.S., F.G.S.

In this note the author stated that four species of Brachiopoda collected by Mr. Judd were especially worthy of notice, two of them being quite new, and two new to Britain. Three of them were obtained from the equivalent of the Kimmeridge Clay, which was the more remarkable as the Brachiopoda of that formation are comparatively few. The new species described were *Rhynchonella Sutherlandi* and *Terebratula Joassi*, derived, with *Terebratula humeralis*, Röm., from the Upper Oolite of Garty in Sutherland; the fourth species is *Terebratula bisuffarcinata*, Schlot., from the Lower Calcareous Grit of Braamberry Hill. This note is intended to form an appendix to Mr. Judd's paper on the Secondary Rocks of the east coast of Scotland, and is accompanied by a plate.

2. "On Solfataras and Deposits of Sulphur at Kalamaki, near the Isthmus of Corinth." By Prof. D. T. Ansted, M.A., F.R.S., F.G.S.

After noting the traces of volcanic action east of the Pindus chain, the author described the Solfataras and sulphur-deposits of the neighbourhood of Kalamaki as furnishing indications that there is even now a real though subdued volcanic energy in this part of Europe. At this place, about three miles east of the Isthmus of Corinth, there is a series of cream-coloured and grey gypseous marls, broken by narrow gorges and fissures. These marls, the stratification of which is much disturbed, are loaded with sulphur. In the principal gorge there are several lateral fissures, forming caverns, communicating with the interior by deep cracks; these caverns are completely lined with crystals of sulphur and other volcanic minerals, and are rendered inaccessible by the large body of hot stifling vapours constantly emitted through them. The temperature of this vapour, where it can be reached, is about 100° F., but the floor of the caverns is too hot to stand on even near the entrance. The author is of opinion that the rocks in this gorge might be profitably worked for sulphur. Similar phenomena occur in several other places within about a mile of the ravine described; and the author was informed that this was the case also several miles further to the east.

The author adverted to other signs of volcanic action to the west of these Solfataras, and especially to the structure of the Acropolis of ancient Corinth, and inferred that lines of volcanic action parallel to the spurs of the Alps of which Etna and Vesuvius and Santorin are the modern vents, ranged far to the north at no distant period.

Discussion.—Admiral Spratt mentioned a cape in the Gulf of Ægina, which within the historical period has risen to a considerable extent, some hundreds of feet, and thus illustrates the influence of modern volcanic action.

Mr. W. W. Smyth wished that the author had drawn a more distinct line between the Tertiary beds containing sulphur and those of still more recent origin. The beds near Corinth reminded him much of some in Transylvania, and he was anxious to know whether the direction of the fissures or other phenomena indicated any great disturbance of the strata.

Prof. Ansted, in reply, mentioned that the fissures ran approximately north and south, and were as nearly as possible parallel. He considered that they were connected with the disturbances which have taken place in comparatively recent times along the eastern coast of the Morea. The sulphur, which usually occurs in small globular masses in gypseous beds, was found in these Solfataras in a crystalline form, and in connexion with the fissures from which the heated gas issues. There was therefore a marked difference in the manner of its occurrence both in Italy and Greece. In Greece the sulphur deposit in nodules was found on the west of the principal chain of mountains, and the crystalline sulphur on the east. In Italy the crystalline sulphur is limited to the vicinity of Vesuvius, and the nodules are abundant both in Sicily and on the east coast of the main land.

3. "On the Origin of Clay-ironstone." By J. Lucas, Esq., F.G.S.

The author commenced by giving a general view of the varieties, chemical composition, and mode of occurrence of Clay-ironstone, and suggested that the formation of all the bedded varieties may be explained by the supposition that they originated in peaty or non-peaty lagoons or the alluvial flats of the deltas of the Carboniferous formations, which would present semiterrestrial conditions, that is to say a surface exposed to the air, but subject to be covered by floods. Carbonic acid formed in the lagoons from decomposing vegetable matter, meeting with protoxide of iron in solution, would unite with it to form carbonate of iron, which, with the mud of the lagoon, would produce Clay-ironstone. Thus, in the author's opinion, the beds of Clay-ironstone, like Coal-beds, mark terrestrial horizons. The author supported his views by reference to various sections, and also cited the occurrence of what he regarded as an analogous phenomenon on a small scale in some mud obtained from the shore between Redcar and Saltburn.

Discussion.—Prof. Ansted thought that the explanation offered by the author, though satisfactory for instances of limited thickness and confined area, was not equally applicable to the far larger deposits, such as those in America, extending over hundreds of square miles, and many times as thick as those described. The beds had by some been considered as due to segregation subsequently to deposition; but this view also seemed hardly such as could be generally accepted. The deposits of ironstone varied much in character, sometimes consisting of layers of distinct nodules, sometimes of continuous bands. The origin of these two classes appeared to him to have been different, and in some of the Coal-deposits the ironstone bands were present on a more extended scale than seemed consistent with the author's theory.

Prof. Ramsay thought that the paper exhibited considerable ingenuity, and that the examples given by the author were intended by him to be equally applicable to large areas. The estuarine character of much of the Coal-deposits was an acknowledged fact; and the theory proposed by the author was quite in accordance with such a state of things. He did not agree with him that ironstone was never deposited in marine strata, as it occurred in the Yoredale beds and in some Liassic beds. As to the deposits of ironstone in freshwater, he referred to those still taking place in some of the Swedish lakes.

Mr. Forbes, whilst admitting that in many instances Clay-ironstones had been deposited in circumscribed waters or shallow lakes, as is the case with the lake iron-ores in Sweden now actually in process of formation, pointed out that some of the largest Clay-ironstone deposits in England, those of the Yoredale series, contained marine fossils in abundance. On chemical grounds it is not clear in what state of combination the author imagines the iron to be held in solution previous to having been, according to him, converted into carbonate of iron, by meeting with the carbonic acid formed in the lagoons from decomposing vegetable matter; and further, the mere fact that the Saltburn mud effervesced with nitric acid after having been bottled for some days, must not be regarded as necessarily proving the formation of carbonate of iron in it.

Mr. Charlesworth called attention to the nodules of ironstone which were found in the coprolite diggings in Suffolk, as to the origin of which little was known. The banding in the interior of these nodules was posterior to their formation, as was evinced by its following the contours of the exterior, and even of lithodomous borings in them.

4. "Note in vindication of *Leptophlœum rhombicum* and *Lepidodendron Gaspianum.*" By Principal Dawson, LL.D., F.R.S., F.G.S.

This note accompanied some photographs of the remains of plants referred to, and was in opposition to the identification of these remains with the *Lepidodendron nothum*, Unger, as proposed by Mr. Carruthers in his Appendix to Mr. Daintree's paper on the Geology of Queensland (Q. J. G. S. 1872, vol. xxviii., p. 350). The author maintained that his *Lepidodendron Gaspianum* is distinct from Unger's species, although nearly allied to it, and that his *Leptophlœum rhombicum* differs from both generically and specifically. He tabulated as follows the characters of his two species:—

	Lepidodendron Gaspianum.	*Leptophlœum rhombicum.*
Stems and branches...	Long and slender; areoles elongate lanceolate.	Short and stout; areoles regularly or transversely rhombic.
Vascular scars	In middle of areole or nearer upper end, according to the surface exposed.	Always in middle of areole.
Leaves	Short and much curved outward.	Long and somewhat straight, and erect.
Fruit.....................	Small, scaly.	Long, leafy.
Structure	Unknown; probably allied to Carboniferous *Lepidodendra.*	Known to possess a large *Sternbergia*-pith, and to have a very thin cortical layer.

e author further stated that Presl's genus *Bergeria* is Carboniferous, and not nian, and that it has no special affinity with *Leptophlœum* or *Lepidophloios*, and jected to the revival of the name *Bergeria*.

scussion.—Mr. Carruthers observed that, in investigating the plants submitted to by Mr. Daintree, he could only deal with published observations and drawings in lating them with known forms. He considered that each systematic worker was erty to review the conclusions of previous authors; and if he saw reasons for so, to treat their names as synonymous. In *Lepidodendron nothum* of Unger eaves are unknown, but the leaf-scars are rhombic, and the decorticated portion e stem is marked with oval vascular scars. Principal Dawson, in his *Lepido-on Gaspianum*, figures two kinds of leaves, one short and erect, the other r and outward-curved; and he shows the external leaf-scars to be rhombic, and lecorticated condition to have oval markings, both exactly as in *L. nothum* of r. No foliage or fruits of *Leptophlœum rhombicum* have ever been figured by ipal Dawson, except as a restoration; and as these were entirely omitted in his vork, which includes the results of his researches, Mr. Carruthers had determined lentity with Unger's *L. nothum* from the form of the scars, the only characters in the published figures, or supplied now by the photographs exhibited. Mr. tree's specimens put it beyond all doubt that the supposed *Sternbergia*-pith, on Principal Dawson apparently founded his genus, was merely the undeveloped on of the apex of the branch. Mr. Carruthers disputed the characters given as insufficient to distinguish the plants as species, much less to justify their being d in different genera. Length or shortness is obviously accidental to the fossil nents; and their stoutness or slenderness is due to the part of the branch to h they originally belonged. The leaf-scars are not elongate and lanceolate, but bic in Principal Dawson's figures of his *L. Gaspianum*; and if his drawings are , the description of the leaves as outward-curved must be wrong. No value can tached to the position of a vascular bundle, which Dr. Dawson says is some- in the middle of the leaf-scar in the one plant, and always in the middle in the , or to the fact (if it be one) that the internal structure in the one is known, n the other is unknown.

r. Etheridge corroborated Mr. Carruthers's views as to the identity of the three . He thought that the representations given by Mr. Daintree were superior as ds accuracy to those given by Prof. Dawson. He pointed out that at the end of hes, where the scars were crowded together, it was almost impossible to dis-ish the arrangement; and he considered that half the species of *Lepidodendra* in our catalogues would on further examination prove to have had no real nce. We had only to look at a recent tree-fern to recognize the difficulty of ing specific determinations from small or imperfectly preserved specimens.

e Chairman remarked that the Society were always glad to receive communica-from Prof. Dawson, although, of course, there might be a difference of opinion e subject of such obscure fossils as those under consideration, and he trusted a question of such importance might be fairly discussed until a definite con-n was arrived at.

—March 26th, 1873.—His Grace the Duke of Argyll, K.T., F.R.S., President, e Chair.—The following communications were read:—1. "Synopsis of the ger Formations of New Zealand." By Capt. F. W. Hutton, F.G.S., of the gical Survey of New Zealand.

this paper the author gave a summary of the Tertiary and later Secondary for-ns of New Zealand. He stated that he had been able to determine 375 species e Mollusca, 12 of Brachiopoda, and 18 of Echinodermata from the Tertiaries; nder each of the formations which he recognizes he gave the number of species e Mollusca found in it, indicating the number of recent species, and of those ging to other formations occurring in each. He also noticed the range and bution of the various formations. The Tertiary groups of strata distinguished e author are, in descending order, as follows:—I. Pleistocene. II. Pliocene: Newer Pliocene or Whanganui group; 2, the Older Pliocene or Lignite group. Miocene: 3, Upper or Arvatere group; 4, Lower or Kanieri group. IV. cene: 5, Upper or Hawke's Bay group; 6, Lower or Waitewata group. ocene: 7, Upper or Ototara group; 8, Lower or Brown Coal group. As ging to the Mesozoic series, the author also described beds of Danian age, under the name of the Waipara formation. A species of *Belemnitella* occurs in beds belonging to the Ototara group, and also in the Waipara formation. Volcanic action commenced in the North Island during the deposition of the Waitewata group, and has since been almost continuous in the northern, western, and central parts of the island. In the South Island the volcanic formations appear to belong to the later Cretaceous, Oligocene, and Miocene periods. The volcanic rocks of the Chatham Islands belong chiefly to the Upper Oligocene.

Discussion.—Mr. Etheridge remarked on what appeared, from the author's account, to be the great longevity of species in that part of the globe. If the forms had been accurately determined, the per-centage that survived from Eocene and Miocene times into the recent period was very far in excess of what survived in Europe. The Belemnites, if found in Europe in Tertiary Beds, would have been regarded as undoubtedly derived from some Secondary rock. He hoped that researches in the Australian Miocene rocks might throw some light on this subject, but as yet little had been done.

Mr. Blanford stated that in India, so far as was known, there was a marked distinction to be drawn between the Eocene rocks, which were mostly Nummulitic, and those of Cretaceous age. In illustration of the occurrence of unlooked-for forms, he mentioned the startling fact that Dr. Waagen had lately found *Ammonites* associated with *Goniatites* in Carboniferous rocks.

Prof. T. Rupert Jones recalled the intermingling of Cretaceous and Tertiary genera in the north-western territories of America, and the combination of forms noticed by Mr. Jenkins in Japanese strata, where Middle Tertiary and other shells, which had been regarded as extinct, were found with recent species.

Prof. Ramsay remarked that when in one part of the world there was unconformity of structure and a break in the sequence of the rocks, there must of necessity have been in some other part an undisturbed area in which the different forms of life would have been preserved, and where, therefore, it was probable that the representatives of the Transitional period between the unconformable rocks would be found.

2. "On the Tree-ferns of the Coal-measures, and their relations to other living and fossil forms." By W. Carruthers, Esq., F.R.S., F.G.S.

After referring to the remarkably uniform character of the order of Ferns throughout their whole history on the globe, the author pointed out that there existed in the Coal-measures two very distinct kinds of fern-stems, each represented by several species. Both of these were very different from the *Chelepteris*-group already described by the author in the Journal of the Society. The first group had a stem-structure like that of living tree-ferns. In them the vascular elements of the stem formed a closed cylinder round the pith; and the vascular bundles for the leaves were given off from the out-turned edges of the cylinder, where, at regular intervals, corresponding to the position of the leaves, narrow meshes occur for this purpose. To this group were referred the stem described by Lindley and Hutton as *Caulopteris Phillipsii*, and several hitherto undescribed species from Radstock and Newcastle. No materials had yet been detected which could throw any light on the foliage or fruit of these fern-stems. The second group included some stems the casts of which the author had obtained from Radstock, and the root-structures from Halifax. By the help of a fine series of specimens in the collections of the British Museum, he was able to correlate the different parts of these plants. The stems had been described by Corda under the name of *Stemmatopteris*. They differed from the other group chiefly in having the ends of the vascular plates, as seen in the transverse section, turned inwards, and having the bundles of the leaves formed in a complete condition in the axis of the stem. The author showed that the relation of the different parts of the stem in the species of *Caulopteris* was the same as in a first year's dicotyledon, while in the latter group the analogy of the structures was with the monocotyledonous stem. The roots, which surrounded the older portions of the stem, formed the well-known genus *Psaronius* of Cotta; and as this was the earlier name, it was proposed to retain it for the genus. There was associated with all the fine specimens of this group, which he had received from J. M'Murtrie, Esq., F.G.S., foliage which had been described as *Cyatheites arborescens*. Although this had not been observed organically connected with the stems, the author adduced several reasons for believing that it belonged to them. If this connexion could be established, it was of the greater importance, as this form was known in fruit; and the fruit established that its affinities were with the living Alsophilas and Cyatheas. Many species of this genus occurred in the continental coal-fields; but the author believed that all the specimens found in England, though differing considerably amongst themselves, belonged to a single species.

Discussion.—Prof. Rupert Jones remarked on the combination of organs found in the older forms of vegetable and animal life which were now found separate, and attached to different groups.

3. "Notes on the Geology of Kazirùn, Persia." By A. H. Schindler, Esq. Communicated by Joseph Prestwich, Esq., F.R.S., V.P.G.S.

In this paper, which accompanied a series of specimens presented to the Museum of the Society, the author described the section presented by the hills in the neighbourhood of Kazirùn. The general surface was described as consisting of nearly unfossiliferous Post-tertiary deposits, immediately beneath which is an unstratified marine deposit containing a great abundance of fossils, among which are species of *Ostrea*, *Pecten*, and *Cidaris* (?). Below this deposit is a succession of strata, repeated several times in the hills, and at the bottom of the series in each case is a bed of gypsum. The spaces between the recurrent series are filled up with conglomerates. Beneath the gypseous series is a formation of compact limestone, which rises to a height of about 1500 feet both north and south of the plain of Kazirùn; its beds dip 25°, and their strike is from N.E. to S.W. The author mentioned the occurrence in a gypsum quarry near Kazirùn of three long cylinders from 6 to 10 feet in diameter, composed of the same material as the surrounding rock. He also stated that he had examined several caverns in the neighbouring mountains, and also the great cave at Shahpoor, but without discovering any organic remains.

Discussion.—Mr. Etheridge was inclined to regard the specimens exhibited as probably of Miocene age. Some of the Pectens resembled those from Malta, and a Crinoid appeared also not to belong to an earlier stage than the Miocene.

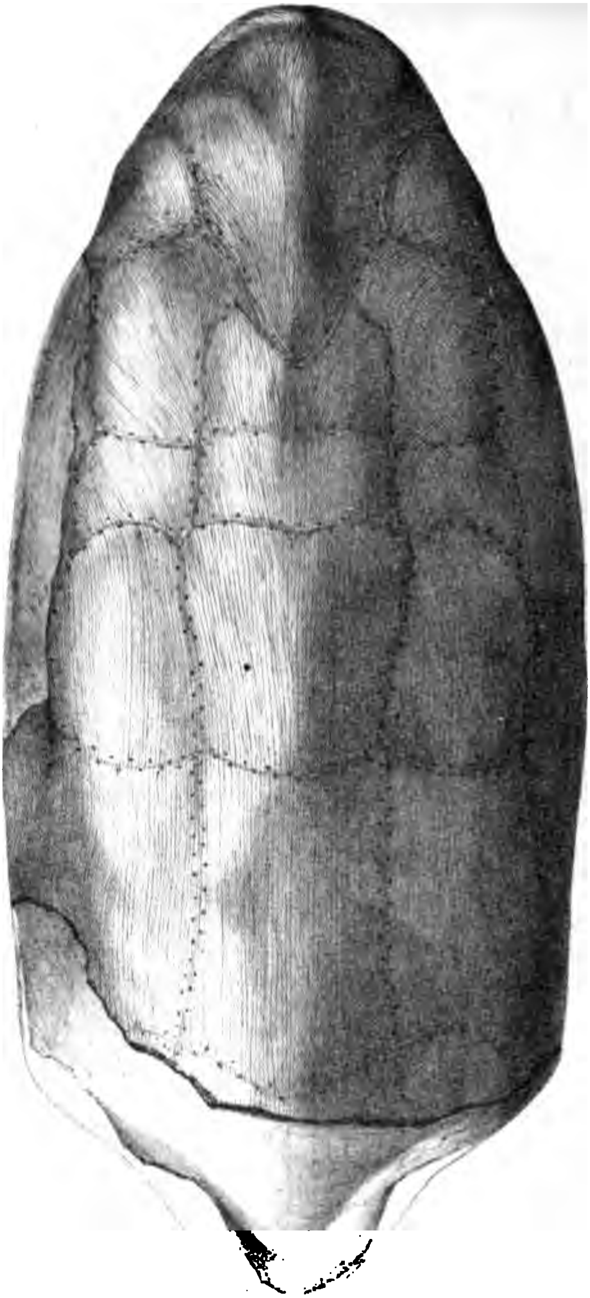
Mr. Blanford mentioned that at Shiraz the formation was nummulitic, but along the shores of the Persian Gulf the beds appeared to be of more recent age, containing some existing forms. He thought that possibly the beds described at Kazirùn belonged to the same series. He did not, however, recognize any of the few fossils exhibited as belonging to the rocks on the shore of the Gulf.

Geologists' Association.—April 4th, 1873.—Professor Morris, F.G.S., Vice-President, in the Chair.—1. "On the Diamond-fields of South Africa," by G. C. Cooper, Esq.

The theory of an igneous action upon the spot at which the diamonds are now found being the explanation required to solve the problem of their origin, was opposed by the author, who adduced facts from his observation in support of the opposite conclusion. He did not consider that the numerous trap-dykes which characterize the South African Diamond Fields had broken through the present surface, which, on the contrary, had been produced, he believed, by the accumulation of materials brought by aqueous agency subsequent to the volcanic action which had formed the dykes. These materials consisted of a surface layer of red sand, overlying a bed from five to seven feet thick, of fragments of "lime and claystone"; and beneath this the diamantiferous marl or "stuff" is reached. Steatitic or magnesian matter forms a considerable proportion of the "stuff," which it was contended may have been brought from magnesian rocks at a considerable distance by water, and possibly by ice-action, and deposited in the hollows between the trap-dykes, and that these magnesian rocks may have been the original matrix of the diamonds.

2. "On some Fossils from the Chalk of Margate," by J. W. Wetherell, Esq.

The author had devoted some time and attention to the exploration of the Chalk in the immediate neighbourhood of Margate, and had obtained as a result a large number of species of fossils, a list of which was given, with remarks as to their relative abundance. In addition to many genera usually common in the Upper Chalk, *Belemnitella* appears to be well represented in the Margate Chalk, and Ammonites are also found; but perhaps the most abundant fossil is the *Coscinopora globularis*, which varies in size from that of a walnut to a pin's head. Crystals of selenites were found as well as concretions of iron pyrites, but minerals are by no means common in the Chalk of Margate.



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THE

GEOLOGICAL MAGAZINE.

No. CVIII.—JUNE, 1873.

ORIGINAL ARTICLES.

I.—On *Holaspis sericeus*, and on the Relationships of the Fish-genera *Pteraspis*, *Cyathaspis*, and *Scaphaspis*.

By E. Ray Lankester, M.A.
Fellow of Exeter College, Oxford.

(PLATE X.)

THE paper of Dr. A. Kunth, "Ueber Pteraspis," Zeitschr. der Deutschen Geol. Gesellsch., 1872, Hft. 1, came into my hands at a time when I had just been examining the specimen of which a restored figure is given in the Plate accompanying this paper. I took an early opportunity of replying to Dr. Kunth's adventurous assertions in the *Academy*, and the remarks then made have been reproduced in this Journal (April, 1873). I need, therefore, here, in reference to that matter, only make one or two additional observations. Dr. Kunth based his statements on a single specimen in a bad state of preservation. His figure shows how inadequate the specimen is to support his views. Out of the many hundreds—I may even say thousands—of specimens of *Heterostraci* which have passed through my hands, I could easily pick several exhibiting all varieties of juxtaposition of *Pteraspis* with *Scaphaspis*, and of specimens of a single species of either genus with other specimens of the same species. The packing of several shields one within another not unfrequently occurs, as happens very generally in the embedding of concave shells. The mere association of these shields, as in Gallicia and in Herefordshire, is not a phenomenon on which any one familiar with them—through examination of numbers of specimens from various localities—would venture to base any argument as to structural connexion. Dr. Kunth has been misled in this respect by the isolation of his drift-block. The lateral piece between "head" and "tail" shield, which Kunth accepts as a locomotive or masticatory organ with so much facility, is simply an indefinite fragment; as are the supposed indications of a jointed body-structure or segments lying between head and tail plate, which Kunth tells us are altogether disarranged, and which he could not develope from the matrix. If we were to proceed in Dr. Kunth's way in the interpretation of some of our crowded specimens of Herefordshire *Heterostraci*, or with those slabs containing *Scaphaspis* shields and fragments of every shape and size from the Cornish coast, it would be easy to make out that the *Heterostraci* were turtles, crocodiles,

OBITUARY.

MR. WILLIAM HARDING BENSTED.

We regret to have to record the death of W. H. Bensted, Esq., which took place at his residence near Maidstone, on the 2nd of April, at the age of 71.

Mr. Bensted was well known to Geologists as the proprietor and worker of the extensive and interesting Kentish Rag quarries, near Maidstone, in which he discovered, in 1834, the greater portion of the skeleton of an *Iguanodon.* This specimen, the only one as yet discovered in which the bones of the same individual have been found in juxtaposition, was first described and figured by Dr. Mantell, in whose museum at Brighton it formed a principal object of attraction, previous to its purchase for the National Collection. It was subsequently described and figured by Prof. Owen, in a Monograph for the Palæontographical Society for 1851, and more recently by Prof. Huxley; and it has furnished the best data to each of these authors, for the reconstruction of the skeleton of this huge extinct reptile. Among other remains found by Mr. Bensted in these quarries, may be mentioned a new species of *Plesiosaurus* (*P. latispinus*, Owen), and two fossil plants, *Abietites Benstedi* and *Dracæna Benstedi;* these are preserved in the British Museum, and various vertebrate and invertebrate remains have been deposited by him in the Charles Museum at Maidstone, an Institution in which he took great interest.

He was the first to direct Dr. Mantell's attention to the amorphous nodules and carbonaceous substance found in, and intermingled with the shells of *Trigoniæ* and other mollusks, and to suggest that these substances are the remains of the soft bodies of the molluscous shells with which they are associated, and which has been named by Dr. Mantell "Molluskite" ("Medals of Creation," p. 431).

Mr. Bensted was also the discoverer, in the Chalk of Burham, of the small marine turtle which bears his name (*Chelone Benstedi*). It was first described by Dr. Mantell as a species of *Emys* in the Philosophical Transactions in 1841, and again by Prof. Owen, who determined its true affinity, in his Monograph of British Fossil Reptiles in 1851.

This specimen, which is also in the National Collection, is valuable as being the first which conclusively determined the existence of marine turtles during the period of the deposition of our English Chalk.

He published in the fifth volume of the "Geologist" some interesting and valuable papers on the "Geology of Maidstone," which contain an excellent description of the various beds or divisions of the Kentish Rag.[1] His knowledge of the geology of the country surrounding that town, rendered his services as an intelligent and able guide, and expounder of its Cretaceous and Tertiary deposits, in much request by geological visitors and excursionists to that neighbourhood, services which he was always ready with cordial geniality to tender.

W. D.

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[1] Geologist, 1862, Vol. V., p. 294, p. 334, p. 378, p. 447.

orbital notch they are also disposed, in correspondence with the indented contour-line. Other irregularities in the surface-striations are best appreciated by an examination of the figure, which is a faithful representation of the specimen, restored only in so far as one side is conclusive as to the other.

On this shield are a very large series of those minute indentations arranged in linear series—looking like short scratches made with a pin on the surface of a soft substance—the existence of which I have pointed out and figured in *Scaphaspis Lloydii*, and in *Pteraspis rostratus* and *Crouchii*. They are well seen in the restorations, figs. 8 and 9 of pl. vii. and in figs. 1 and 4 of pl. i. of the Monograph. There is little doubt that they are the sites of soft tegumentary structures, in all probability of those characteristic sensory-follicles of fishes, with which they agree in disposition. The occurrence of these "pits" in *Scaphaspis* and *Pteraspis* is an additional piece of evidence, confirmatory of the fish-origin of the shields of *Heterostraci*, which Kunth has ignored. The disposition of the pits in *Holaspis* will be best understood by an examination of the figure. (Plate X.)

The detection of this new form of Heterostracous fish is satisfactory on other grounds besides the demonstration it affords of a transition from the simpler form of *Scaphaspis* to the more elaborate *Pteraspis*. It justifies the expectation that the Cornstone fisheries have not yet been exhausted by the geologists of the Welsh border, and we may with hopefulness urge them to continue their labours. Well-preserved bodies with fins and scales of *Pteraspis* and *Scaphaspis*, additional evidence of the post-cephalic scutes of *Zenaspis Salweyi*, and altogether new forms of allied genera, are waiting for their hammers.

In addition to Kunth's and Magister Schmidt's expressions of dissent, there is yet a third attack upon some of the views put forward in my Monograph which has to be met, and is in fact answered by what has been said above. Von Eichwald, in a paper presented to the Society of Naturalists of Moscow, 3rd October, 1871, has some observations on *Palæoteuthis.* I am acquainted with his paper through a translation contained in M. de Lacaze Duthiers' admirable Archives de Zoologie, Jan., 1873. With all due regard to Eichwald's opinion, I must point out that it is lamentably devoid of basis. If he had only seen a few or even one specimen of each genus from our English localities, he could not possibly have maintained it. Eichwald admits that *Pteraspis* (as limited by me) is a fish, but he maintains that *Scaphaspis* is a cuttle-bone, and particularizes *Scaphaspis* (*Palæoteuthis*) *Dunensis*, and *Sc. Kneri.* The fact is—which Eichwald has never had an opportunity of observing—that the minute markings and structure of *Pteraspis* and *Scaphaspis* (*Sc. Lloydii*, *rectus*, and *Sc. Kneri* especially), are so exactly like those of *Pteraspis* that their agreement is appealed to as support for the view that they are as Dr. Kunth maintained—parts of one animal. That whatever may be the nature of *Pteraspis*, the same nature belongs also to *Scaphaspis*, is beyond all possibility of doubt established.

I must again mention what I published some two years since in the GEOLOGICAL MAGAZINE, viz. that I was enabled after a long day's searching with Dr. Reuss, at Vienna, to examine Kner's original specimens from Gallicia, and that although from Kner's figure I was led to coin the name *Sc. Kneri*, yet had these specimens been placed before me, I should have mistaken them for Herefordshire specimens of *Sc. Lloydii*—so closely in every detail of structure and marking and mode of weathering did the Gallician fossils correspond with the English ones. I have also previously noticed the fact that *Pteraspis* was present as well as *Scaphaspis* in some of Kner's specimens.

I have not yet had the opportunity of reading Herr Magister Schmidt's paper on *Tremataspis*, and may probably have some additional remarks to make when I have managed to get a sight of what must be a very interesting memoir.

II.—ON ROCK FISSURING.

By J. CLIFTON WARD, F.G.S.,
Associate of the Royal School of Mines; of Her Majesty's Geological Survey.

MANY curious cases of rock fissuring have attracted my attention while working out the geology of part of the English Lake-district. A notice of some few of them may perhaps draw forth remarks from those who have had longer and wider experience in the field of nature.

First, as to the facts observed. Most of the instances I shall mention are those of fissures in mountain masses, into which rock-fragments have fallen more or less from either or both sides, but of which there is no indication upon the flanks of the mountains in the form of slips. A notable case is that of Helm Crag, near Grasmere, well worthy of a visit from the geologist or the mere searcher after the picturesque. The summit of The Helm (1298 ft.) is traversed by several parallel, narrow, but deep fissures, into which the rocky fragments on both sides have fallen, and the conspicuous rocks, "The Old Woman Cowering" and "The Lion and the Lamb," occur along the lines of fissure.

I had long been struck with the resemblance of certain rocks on Rosthwaite Fell (just N.W. of Glaramara), as seen from below Rosthwaite, to those on the Helm Crag, and on going over the ground I found that they also were rock-masses tumbled along short parallel lines of fissure, only the fissures were not so deep or well-marked as on The Helm. This craggy spot goes by the name of Rosthwaite Cam, and is 2000 ft. in height.

Upon the summit of Kirk Fell, 2630 ft. (just west of Great Gable), are a number of felspar-porphyry and syenite dykes running north and south, which are generally marked by more or less of a track over the ground, and west of these, and having nothing to do with the trap-dykes, are a number of linear depressions or trenches meeting one another at various angles, and frequently having one side covered thickly with large angular tumbled blocks. Some of these present a grassy side and bottom, faced by a steep wall of blocky fragments.

None of them are much more than from 12ft. to 20ft. in depth, and they are found *not* on the steep western sides of the mountain, but for the most part on the stony table-land above the 2000 ft. contour. They differ from the fissures of Helm Crag in being closed and often grassy along their beds. In one case I found that a well-marked and long trench joined up to the line of a small fault.

Perhaps, however, the finest instance of this fissuring is that upon the mountain-top just north-east of Illgill Head, overhanging Wast-water, a continuation of the line of craggy mountain forming the Screes. The steep mountain-side above the lake presents no appearance of slips, but on the summit the ground is cut up in the most marvellous manner by fissures for the most part running in the same direction as the hill-side. They are roughly parallel to one another, and present a plan of what might be an area of faulted country, in which the inequalities at the surface had been produced more quickly than the denuding agents could remove or soften them down. In one place may be seen a line of tumbled craggy rocks upon one side of a line of fissure, the ground being depressed upon the other side; and in another place the apparent subsidence, or throw, has taken place in an opposite direction; while there is at least one good example of a tract of ground let down between two parallel fissures, reminding one of a trough fault.

There are many other cases in the district of a similar nature to the above, though not always so well marked, but in all those just noticed there is no indication of a slipping away of the hill-side. Instances where there is this indication are more frequent, but then it is not the mountain-top that is fissured, but the mountain-side.

The examples mentioned above, all occur in rocks of the Borrowdale Volcanic Series (Green Slates and Porphyries), nor have I yet noticed any good cases of this class among the mountains made up of the Skiddaw Slates. How are such fissures to be accounted for? Does any one of the following suppositions seem likely?—

1. That they are strictly of the nature of slips; that is, the mass of the mountain, or any part of its mass, is pressing outwards or towards the flanks.

2. That they have been caused by earthquake shocks, perhaps very long since.

3. That they are the outward expressions of faults slowly taking place, and represent much greater disturbances or shifts at considerable depths.

I can conceive of no other theories than these to account for their formation. Let us consider their respective merits. With regard to (1) the facts that the mountain-*side* has no slipped appearance, and that the fissures often occur on a more or less flat-topped mountain, are against this supposition, though the ease with which one can imagine a great slip inclines one rather naturally towards it.

That (2) is a possible cause no one will deny, though in this case it seems almost strange that the fissures should not be more frequent than they are, seeing that the shocks must always have been more or less felt over so small a district whenever they occurred strongly *at one part.*

Against (3) an objection might be raised that they occurred only among certain rocks of the district, whereas faults would be likely to be found without any such marked restriction. But I do not think such an objection would hold; the non-occurrence of the fissures of this class among the Skiddaw Slate mountains is probably due to the nature of the rock; if fissured gradually, or even suddenly, the readily splintering and shivering slate would close the crack almost directly, so that it would be unperceived, whereas among the hard and *blocky* rocks of the Volcanic Series the fissure would stand open, or have large angular blocks wedged in it.

There is certainly no reason why faults should not now be in process of formation beneath our feet; the action may be imperceptible because so slow, and denudation may be obliterating any outward marks of faulting as fast as they tend to be formed. Many faults may be produced among rocks deep down, without the topmost layers being disturbed, as is occasionally proved in collieries, where a fault sometimes affects a lower bed of coal but not an upper; but in some cases, at all events, the faulting action might reach the surface. If such action took place gradually, one would not expect to meet with much surface evidence of it among soft rocks, in which abrupt inequalities would be smoothed down as fast as formed; or over those areas which have only been dry land for a short period; but rather among hard jointed rocks, and over areas which have existed as dry land for long periods of time. Now as regards this last point, I think there is every evidence to show that the mountain district of Cumberland and Westmoreland has existed as an area of dry land ever since the close of the Carboniferous Period, or perhaps since that of the Old Red, with the exception of the partial submergence during Glacial times, when the higher mountain tops were even then above water. Still the time since the close of the Glacial Period is itself so great, that longer periods may be left out of reckoning, and moreover, any open fissures or great rents would probably be completely effaced by the movements of snow and ice over a rocky country strewn with fragments.

On the whole, I am rather inclined to think that supposition (2) is the simplest, and the simplest is generally the truest; but at the same time the mind is greatly tempted to dwell on any indications of great forces—the former effects of which we see around us—still working quietly and effectively.

Before closing the subject, I should like to say a few words upon the singularly stony nature of the summit of Scafell Pikes and some other mountains. In the case of Scafell, the summit of the mountain as far as Great End is thickly strewn over with large rough blocks of stone, so that one's progression is often limited to jumping from block to block. The masses are not travelled, but are evidently lying only just out of place. Last summer I carefully examined some of the rock-masses which were still in place, and found them often much jointed and fissured, the blocky fragments tending to topple over into the fissures. At one spot this was particularly well seen,—a fissure traversed a well-jointed mass of close altered ash, along its line blocks were falling into it at various angles, and on either side the rock was shattered, and its parts more or less displaced. On seeing this instance, the thought was at once suggested that the blocky nature of the ground was due to rock fissuring and rock weathering, and further examination seemed to lend support to this view.

If I remember aright, Darwin, in his "Voyage of a Naturalist," describes some singularly stony and blocky ground on hills in the Falkland Islands, to which the Scafell tract would seem somewhat similar, but the cause of which was not very evident. Is it possible that the explanation just applied to Scafell might apply to this case also?

KESWICK, *April 4th*, 1873.

P.S.—The above article was already in type when Dr. Ricketts' communication on "Fissures, Faults, etc.," appeared in the May Number of this MAGAZINE. I do not see, however, that he throws any light on the formation of fissures, since in Dr. Ricketts' opinion earthquake shocks are produced by the action of faulting, and "previous to a fault being formed, a fissure must have taken place" (p. 204). What is the precise cause of the first formed fissure, Dr. Ricketts does not state; but it is clear he does not connect it with earthquake shocks. Space will not permit me to do more at present than add this postscript.—J. C. W.

KESWICK, *May 20th*.

III.—ON THE FORMATION OF MOUNTAINS, WITH A CRITIQUE ON CAPTAIN HUTTON'S LECTURE.

By REV. O. FISHER, F.G.S.

THE subject of Captain Hutton's lecture,[1] on the Formation of Mountains, delivered at Wellington, New Zealand, is one which has engaged a good deal of my attention, and was discussed by me in a paper read before the Cambridge Philosophical Society, and printed in their *Transactions*.[2] In that paper I attributed the elevating force, which has raised mountain ranges, to the contraction of the heated interior of the earth, and subsequent wrinkling of the crust so as to accommodate itself to the diminished nucleus. This was an old hypothesis, but I believe the amount of horizontal pressure produced in that manner had not been estimated before. Mr. Mallet, the eminent seismologist, read a paper on the same subject before the Royal Society in May, 1872, in ignorance of what I had written, and came to the same conclusion as myself as to the amount of the horizontal pressure. And the late well-known mathematician, Archdeacon Pratt, in a note to the last edition of his 'Figure of the Earth,'[3] indorsed my result, which I give in his words: "The Rev. O. Fisher shows, that the horizontal force of compression, thrown into a stratum at the earth's surface, by the shrinking of the parts below it, will equal the weight of a piece of rock of the same section as the stratum, and 2000 miles long, enough to crumple up and distort any rocks."

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[1] GEOL. MAG., Vol. X., p. 166.

[2] Vol. xi., part iii. See also GEOL. MAG., Vol. V., p. 493.

[3] Figure of the Earth, fourth edition, p. 203, note.

Captain Hutton supposes, after Babbage, that the deposition of a stratum at the bottom of the ocean would raise the temperature of the rocks underlying the original surface by 2° Fahr. for every 100 feet laid down upon it, and "that the irresistible pressure caused by the expansion of the rock could only be relieved by the whole stratum bulging upwards, and forming an arch, or, more properly, a dome." And, by calculating the altitude of this arch, he deduces the height of the resulting mountains.

My present object is to explain why I think this reasoning not conclusive. For the theory is one that would be likely to obtain favour, partly because it appeals to the known denudation of the surface, which has been lately so well estimated by Mr. Croll and others, and partly because it seems to support those uniformitarian doctrines, which are supposed to be of paramount value in geological speculation. I also wish to bring forward some general conclusions which have occurred to me in the course of testing the proposed theory.

In the first place, then, I think that Captain Hutton is mistaken in his notion of the conditions of equilibrium of the crust. He says, "Each portion of this rigid crust must be maintained in its place by three forces, viz. its weight, the lateral thrust of the arch, and the outward pressure of the superheated interior," where, by the "thrust of the arch," he seems to mean the horizontal pressures at the ends of a section of the crust considered as a spherical rigid shell. Now we have no right to consider the crust rigid[1] when regarded in portions of sufficient dimensions to admit of these lateral pressures being otherwise than sensibly in the same straight line but in opposite directions. It is also evident by the merest inspection of any natural section that the rocks cannot be considered by any means rigid. The true statement of the conditions of equilibrium of a portion of the crust considered rigid (for which purpose it must be taken infinitesimally small) is that it is kept in equilibrium by *two sets* of forces, (1) the two horizontal pressures upon its ends acting in opposite directions and equal in amount, and (2) the vertical forces consisting of the weight of the portion of crust under consideration, and the upward pressure of the rocks beneath, also equal to one another. These two sets of forces must be *separately* in equilibrium, because they are each set at right angles to the other. Hence it is not true that "if one or more of these forces change in amount, the equilibrium will be subverted;" for it is evident that the horizontal pressures may be both equally increased, or both equally diminished, without affecting the equilibrium: and this is the case we have to consider.

Captain Hutton argues, I think truly, that, "if an upheaval of the crust should take place at any point, the underlying superheated rocks, being thus relieved from the pressure above them, would expand and rise up and fill the hollow." Let us suppose, as the extreme case, that a limited portion of the crust, instead of being upheaved, was entirely removed. Then, not considering differences of density, nor ebullition, the underlying rocks would rise up, and form a sensibly level surface with that around the removed portion. They could not rise higher than this. Suppose now, for the sake of argument, that the removed portion of the crust were to be replaced. It would sink back again into its original position. And the same thing would equally happen if it were broken up before being replaced. It seems then that the upward pressure of the subjacent rock has no power to support any portion of a crust of normal density at a level higher than that of the general surface; and, consequently, that any abnormal elevation of a portion of such crust must be owing to lateral pressure. The question at issue is, what is the cause of that pressure, and what amount and form of elevation would ensue from it? Captain Hutton's hypothesis, properly applied, would produce results nearly analogous to that investigated by myself in 1866, and by Mr. Mallet in 1872, with this obvious difference—that on Captain Hutton's supposition the crust would expand away from the nucleus; whereas in ours the nucleus contracts away from the crust. Other points of divergence will be pointed out in the sequel.

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[1] It might be thought, on a cursory view, that I have taken this view myself which I now condemn in my paper on the Elevation of Mountains, p. 4, but a little consideration will show that it is not so.

The author of the lecture assumes rocks to expand on an average 0·000005 of their (linear) dimensions for 1° F., and on that supposition gives a table of the altitudes, which, according to his theory, would be attained by the arch caused by the expansion of an area of given width, when exposed to a given rise of temperature.

I have not been able to obtain the same numbers; but mine do not differ materially from his. The elevation of the highest point of a circular arch, constructed according to Captain Hutton's supposition, comes out with me equal to the following expression—where a is the earth's radius, and e the expansion of rock for the increase of temperature under consideration:

$$\frac{3a\,e}{2}\left(1+\frac{3e}{4}\right)+\frac{e}{8a}\,(arc)\;2.\,^{*}$$

whence I obtain the following table:

Thickness	500 feet.	2500 feet.	10,000 feet.	25,000 feet.
Temperature	10°	50°	200°	500°
Breadth 100 miles......	1567	7835	31,340	78,360
„ 500 „	1569	7845	31,380	78,460
„ 1000 „	1575	7875	31,500	78,750
„ 2000 „	1600	8000	32,000	80,010

(N.B.—This table is not to be taken as representing in the opinion of the author of this paper what occurs in nature.)

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[*] This supposes the arc considerably larger than *e×radius*, as will be the case in every instance in the table.

Let us now consider what would be likely to take place under the conditions supposed. If 10,000 feet of deposit were laid down, and the underlying rocks raised in temperature thereby 200°, they would expand by $200 \times 0{\cdot}000005$ of their previous linear dimensions; that is to say, a cubic foot of rock would, if free, have each of its faces removed further from the opposite one by 0·012 of an inch, which is about double the thickness of a sheet of stout writing-paper. Such is the amount of expansion relied upon to produce the considerable elevations given in the fourth column of the table, and which no doubt it *would* produce, were the rocks absolutely rigid, and were they to be elevated by the said expansion into a *circular arch;* to both of which positions I demur. Now, fixing our thoughts upon such a cube of one foot of rock, it certainly seems probable that, under great horizontal pressure, it would undergo the small amount of *compression* indicated by this computation, and not expand at all horizontally, but simply become about one-hundredth of an inch higher. Or else the *whole* expansion would take place in the vertical, the block suffering slight *deformation* and becoming about three-hundredths of an inch higher than it was originally. Far greater deformation than this has accompanied slaty cleavage.

Such reasoning would lead one to doubt elevation of the kind supposed by Capt. Hutton being produced at all by such a small amount of expansion. For it must be recollected that the pressure caused by the expansion is horizontal, or very nearly so, and I have already explained that there is really no vertical pressure from below, except what just supports the rocks in their normal position. If the process I have last described actually went on, then we should get over the whole area an equable elevation of $3 \times 0.000005 \times t \times$ *thickness of rock whose temperature is raised* t°.[1] To how great a depth that rise of temperature would happen, I think we cannot tell. But conduction would probably equalize the temperature to that due to the general level, long before any great depth was reached. And we must recollect that the heat, which goes to raise the temperature of the expanded layer, is abstracted from the layers underneath it, so that contraction in these will accompany the assumed expansion of those.

We have hitherto considered that the expansion of a layer of rock would not disturb its position, but produce only an increase of its thickness in a vertical direction. But since it is evident that in nature elevation has in most instances been caused by lateral compression, I will endeavour to estimate, in a general way, some of the effects it may be expected to produce, and then apply them to test Capt. Hutton's theory, and also to explain, as far as I can, one or two of the observed phenomena of mountain regions.

For this purpose we will consider that from some cause a layer of rock becomes relatively larger than it was originally; either by itself expanding, or else by the neighbouring rocks shrinking in towards it. I have shown in my paper on the elevation of mountains that an enormous horizontal pressure would result, before which the layer in question, if incompressible, must give way, and its position be disturbed.

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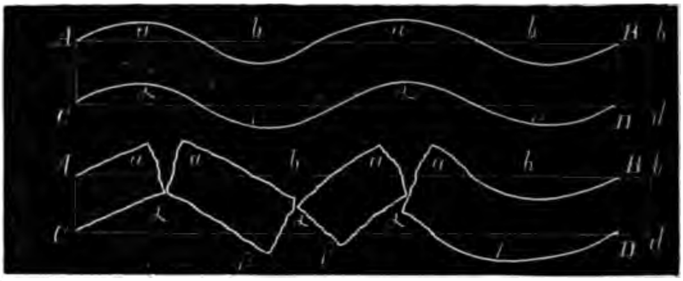
[1] Mr. Babbage, Journ. Geol. Soc., vol. iii., p. 204, entirely neglects the horizontal expansion, and takes account only of the vertical part, so that the elevation I have given in the text is three times as great as he would have reckoned it. As a homely instance of the effect I suppose, may be taken the case of a loaf of light bread baked in a "tin."

But would the horizontal pressure elevate it into an arch or dome? It appears to me more probable that, acting on a layer many times wider than deep, it would break it up into a series of synclinals and anticlinals interspersed with faults, and not cause it to rise in one unbroken arch at all. The pressure of the rocks below is not really capable of doing more than sustaining the original layer in its original position, and, if that becomes weighted by the addition of deposit, the tendency will be towards depression, and not elevation, so that lateral pressure would in the first instance cause it to bulge downwards and not upwards. I think it likely that, the layer once disturbed, the subjacent superheated rocks might rise into the anticlinals, and if so I should expect that the synclinals would equally sink down into those rocks.


1.

2.

Let us suppose *A B C D* to be a layer of rock of unit of thickness, length *l*, and depth *k*, and first that it would expand to *A b C d*, so that $A\,b = A\,B\ (1 + e)$, where *e* is a very small fraction, but that, on account of the abutments at *A C* and *B D* being immovable, it is forced to assume some new form, as for instance that given in the figure (or any other). Call *A B* the datum level. Now the first thing which is evident is that the wavy lines *A B* and *C D* will be shorter than the straight lines *A b* and *C d* respectively, because the stratum is all along subject to longitudinal compression, not only at first, but also finally, because their weight will compress the anticlinals, and the inertia of the subjacent rocks will resist the synclinals being forced down. Hence it is clear that the surface line cannot be longer than $l\,(1 + e)$, but will be, on the other hand, rather shorter and the layer on an average thicker than before compression.

Let us now seek for some simple laws which must govern the disturbed strata in spite of the confusion which appears to reign among them. Let *a*, *a*, etc., be the areas formed by the upper curved line above *A B*, and *b*, *b*, etc., the areas formed by the same line below *A B*. It is not necessary that the *a*'s should be equal to one another, nor yet the *b*'s. They are used simply to designate the areas in respect of their *positions*.

In like manner let a, β, be similar areas for the lower datum el CD. Then the space included between the curved lines hich we will call the "contour" lines) must be equal to

$$AbCd = kl\,(1 + e).$$

It is also evidently equal to

$$\begin{aligned} &ABCD + a + a + \&c. + \beta + \beta + \&c. \\ &\qquad - b - b - \&c. - a - a - \&c. \end{aligned}$$

denoting the sums of the quantities of the same sort by the mbol Σ, we get

$$k\,l\,(1 + e) = k\,l + \Sigma\,(a) - \Sigma\,(b) + \Sigma\,(\beta) - \Sigma\,(a).$$

$$\therefore k\,l\,e = \Sigma\,(a) - \Sigma\,(b) + \Sigma\,(\beta) - \Sigma\,(a). \qquad (1).$$

Let us now suppose that the crushed and contorted mass is solely pported by the superheated rocks below, which, but for the attach- nts at $A\,C$ and $B\,D$, would be absolutely true; and must be very rly true in any case. We may treat the superheated rocks as a id, and apply the conditions of statical equilibrium.

The mass which is supposed thus to float, the fluid being allowed have free access to every part, was in hydrostatic equilibrium ore its expansion and consequent disturbance; that is, its surface uld then have been at the same level as the surface of the fluid. his is the same as the supposition that we made at the commence- nt, p. 250.) It is therefore evident that, upon the expansion of $B\,CD$, or $k\,l$, into $k\,l\,(1 + e)$, the part which would float above the face, would be equal to the additional volume arising from the pansion, because the specific gravities will be inversely propor- nal to the volumes, or (since we are considering the thickness to be ity) to the areas.

$$\text{Hence } k\,l\,e = \Sigma\,(a).$$

Also, since the specific gravity of the expanded mass is supposed rywhere to be less than that of the fluid beneath it, its surface uld be everywhere above the surface of the fluid, unless it was ler constraint, or in other words we should have

$$\Sigma\,(b) = o.$$

Hence, if such hollows as b, b, extend below the datum line, it can ly be under constraint, and since there is more freedom for the ks to be contorted upwards than downwards, we may consider it st probable that there will be no such hollows below $A\,B$. How- r, for the present, we will suppose them to exist, but that the id has not access to them. Then, applying the conditions of drostatic equilibrium, we get, putting ρ and σ for the densities ore and after expansion, the former being that of the fluid, and serving that

$$\frac{\rho}{\sigma} = \frac{1 + e}{1},$$

$$k\,l\,(1 + e)\,\sigma = k\,l\,\rho - \Sigma\,(a)\,\rho + \Sigma\,(\beta)\,\rho$$

$$\therefore \qquad o = \qquad - \Sigma\,(a) \quad + \Sigma\,(\beta).$$

But we have shown that

$$k . e = \Sigma\, r - \Sigma\, [illegible] - \Sigma\, [illegible] - \Sigma\, [illegible].$$

$$\therefore \quad k . e = \Sigma\, r - \Sigma\, [illegible].$$

Hence, if the mass was under such conditions as to admit of the [illegible] [illegible] expanding below the datum level, the above relation would subsist between the areas of sections of the mountains and of their [illegible]. The datum level will be as [illegible] [illegible] [illegible] a surface curved beneath new [illegible].

But if the mass was not under such conditions as to force the [illegible] [illegible], it has already shown $\Sigma\, [illegible] = [illegible]$, then we should have as before

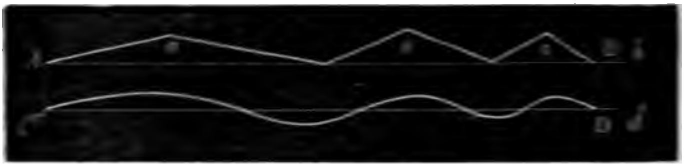
$$k . e = \Sigma\, r.$$

This I consider a very important result. The above considerations give us the further information

$$\Sigma\, s = \Sigma\, [illegible].$$

That is to say the sum of the areas which sag down into the superficial [illegible] will equal the sum of the areas in which the superficial [illegible] rise up into the anticlinals. This is another important conclusion.

2.



I will proceed to consider the more simple case in which the surface of the [illegible] of all the masses, be their form what they may, is above the datum level. See Woodcut 3.

For further simplicity let us consider the sections of the ridges to form isosceles triangles. It is likely that for the same area Σ (a), the average height of the ridges will be slightly greater for such triangles than for curves, and the length of contours will not be very different in the two cases.

It is easily seen that if any number n of triangular ridges be formed all along the datum line, and each triangle out of the expansion of the part of the stratum on which it stands (i.e. $a =$ base $\times\, k\, e$), and if λ be the base of any triangle and η its height,

$$\text{since } \tfrac{1}{2}\, \lambda\, \eta = \lambda\, k\, e,$$

$$\therefore \quad \eta = 2ke.$$

This shows that if each ridge is formed out of the part of the stratum on which it stands, the height of the ridge, so long as we can suppose a triangle to represent it, will be nearly the same, whatever be the width of its base (unless the base be *very* narrow).

If under the same suppositions we conceive the whole disturbance thrown into $\frac{1th}{n}$ of the datum line, and that the area of each triangle is *proportional* to the part of the stratum on which it stands, in that case the height of each ridge will $2\,k\,m\,e$.

If we do not consider each ridge formed out of, or even proportional to, the part on which it stands (which will be more general and probably more in accordance with nature), we have,

$$\Sigma\,\tfrac{1}{2}\,\lambda\,\eta = l\,k\,e.$$

taking for η its average value, which we will call h.

$$\Sigma\,\tfrac{1}{2}\,\lambda\,h = l\,k\,e.$$

$$\text{but } \Sigma\,\lambda = l.$$

$$\therefore\ h = 2\,k\,e \text{ as before,}$$

and if the compression be thrown into $\frac{1\text{th}}{m}$ of the datum line

$$h = 2\,k\,m\,e.$$

which gives this rule to estimate the average height of the mountains. Multiply together the thickness of the layer before its compression, the number of times which the datum line contains the width of the disturbed area, and the coefficient of expansion; and twice this product will give the average height of the mountains.

If a uniform deposit were laid down upon the datum line before the expansion occurred, as in the case contemplated by Capt. Hutton, we should get a very similar result, except that the surface contour line would not coincide with the upper line of the expanded layer, but would run at a nearly uniform distance from it, so that the formulæ already investigated would still be applicable, except that the heights would have to be measured from a new datum line, viz. the upper surface of the deposit. When the deposit had reached its utmost extent, this would be the sea-level, and if such depressions as b, b, were formed, they would probably be seas.

Let us apply our rule to the mountains which would be formed by the expansion of the layer of rock with the data suggested by Captain Hutton. In this case l is the length of the arc, which geometrically is sufficiently nearly a straight line, and mechanically is strictly horizontal, for it is at every point in the direction of the compressing force, and also at right angles to the force of gravitation. We will suppose the ridge or ridges to be formed along the whole of the base line or arc.

Let us take for our instance the fourth column of the table. Here $e = 0{\cdot}001$ and $m = 1$. But k is unknown.

The average height of the mountains will therefore be $2 \times 0{\cdot}001 \times$ *thickness of the heated layer*, or $0{\cdot}002 \times$ *thickness of heated layer*. It is of course independent of the length of the arc.

I will not presume to guess the thickness of rock which would in the manner supposed be heated by 200° F. But whatever assumption be made, the average height of such corrugations as I have assumed would be each of them (were they few or many) ten five-thousandths of that thickness, that is about ten feet high for every mile thick of rock raised 200° F.

Were the corrugations supposed of a curvilinear contour they would be not quite so high. We see then that the elevations which could be produced by such heating and expansion would be quite inconsiderable. I therefore conclude that the first cause suggested by the author is incompetent to produce the effects attributed to it.

It is very important to understand the reason why my conclusion differs so widely from his. I will therefore repeat it. It arises from the fact that Captain Hutton considers that a horizontal force of compression (remembering the true meaning of the word horizontal) would elevate a stratum of rock into an arch or dome, while I consider that it could not have that effect; but that, if the layer of rock was so rigid that it could not yield to the required amount in the direction of the pressure, it would be broken up into a series of synclinals and anticlinals, faulted or not, and that the shortening of the base would be compensated for by the heaping up of the material above the original surface-level. (See Section 2, p. 252.)

We will now consider shortly the instances adduced to give verisimilitude to this theory, which requires to test it that an area of given breadth, with a given thickness of deposit upon it, should rise into an arch, whose height agrees with the data according to the table.

I think that not one of these conditions is truly presented by the Weald in our author's estimates. "The breadth to some point in the English Channel is about 100 miles." In other words, the breadth is unknown, so that we have not the datum required for the first column. "The thickness of the beds is 3400 feet; and the highest part of the arch would have attained, if the upper portion had not been denuded off, a height of 3600 feet above the sea." There is no explanation of what beds are taken account of in the 3400 feet; but since the crest of the arch, if undenuded, would have attained 200 feet more than that, 200 feet of rocks *not* estimated must lie above the sea-level in the centre of the Wealden country. Why are these to be excluded? or why rocks far below these? Again, what are we to say about the Tertiary beds which probably covered some part of the Chalk, and consist of fresh-water as well as marine beds, so that the whole series proves several oscillations of level before the dome-shaped form was finally assumed. Are these to be taken into account? and if so, how is the depression succeeding to the Woolwich beds to be allowed for? These questions are most material before any correspondence of precise measurements can be pretended here between theory and fact.

Again, is it not a mistake to regard the Wealden area as an isolated dome-shaped elevation? Is it not rather one of a series of parallel corrugations, of which this one passes by Devizes, Kingsclere, and Hastings, and the next south of it by Weymouth, Purbeck, and the Isle of Wight, while the whole system of disturbances on this parallel dates back to a period long anterior to the deposition of any of the Wealden rocks, but probably subsequent to the Carboniferous? While the much greater distortions which affect the older rocks on that line, as at Mendip and in Belgium, are the sum of disturbances previous to the Wealden elevation, *plus* those which occurred subsequent to the deposition of the Chalk. In short, we are here on an old line of movement.

With respect to the other illustration, drawn from the great longitudinal elevated region extending from Spain to China, the concomitant Nummulitic formation scarcely proves that the elevation of that tract was the result of its deposition. True it is, however, that Mr. Medlicott traces a connexion between the "supra-Nummulitic deposits" and movements of disturbance in the Shillong Plateau, which he considers an example of "the theory of MM. Herschel and Babbage." But that theory, as I understand it, does not include the arch-movement of Capt. Hutton, against which the above objections are chiefly urged.

Moreover, the effects attributed by Herschel to the weight of new deposits, stand on different grounds, and from the few remarks of Mr. Medlicott, in the passage referred to, it seems to be to these that he alludes.[1]

The above conclusions have been arrived at in accordance with Captain Hutton's assumption that a layer of rock expands through the addition of heat. It will be observed that this introduces the condition that the specific gravity of the disturbed rock is less than it was before.

If, however, the crushing of the layer arises from contraction of the earth's interior, the reasoning will be somewhat altered. In order to get a clear conception of the circumstances, let us suppose a portion of the crust removed before the contraction occurs. We will suppose the superheated rocks below to be *virtually* of the same specific gravity as the crust. They would in that case rise level with the surface. Suppose contraction now to take place. Then the edges of the chasm which we have made will approach one another, but the superheated rock will still rise only to the surface-level, *so far as anything at present noticed is concerned.* We suppose that the width of the chasm we made was $l\,(1 + e)$, and that it contracts to l. But now we cannot restore all the rock that was removed, for $k\,l$ of rock will exactly fill the space, and $k\,l\,(1 + e)$ was what was taken out of it. Hence $k\,l\,e$ of rock must either be left out, or else heaped upon the surface.

Now, if we were only considering a limited area of the earth's surface, the whole $k\,l\,(1 + e)$ of rock would sink into the cavity, being, in the case we are now considering, virtually of the same specific gravity as the fluid beneath. It would sink until the surface was level as before with the general surface, the surplus $k\,l\,e$ of fluid distributing itself throughout the interior, and from its comparatively small amount being, as it were, lost. But since the same amount of shrinking that we have supposed to take place over one area occurs to an equal amount over every equal area, this cannot happen: so that the $k\,l\,e$ of rock must stand above the datum level and form mountains.

Moreover, the condition, that no part of the superheated rock can be lost in the interior, necessitates that any portion of it, which is displaced below $C\,D$, must be compensated for by an equal portion rising above that line. And this will be expressed by the condition that

$$\Sigma\,(\alpha) = \Sigma\,(\beta).$$

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[1] *Geological* Sketch of the Shillong Plateau, Geological Survey of India, p. 40.

The geometrical equation (1) will then become as before,

$$k\,l\,e = \Sigma\,(u) - \Sigma\,(v). \quad (2)$$

And if there be no depressions below the upper datum level, we have, as in the former case,

$$k\,l\,e = \Sigma\,(u). \quad (A)$$

It may be asked why the weight of the rock $kl(1+e)$ should not force back the walls of the chasm until it was wide enough to admit of its reintroduction. The reason is because the lateral pressure caused by the shrinking of the interior is so enormous that that could not happen. Hence, in truth, the rock replaced would be supported somewhat in the manner of a piston.

If this reasoning be correct, as I believe it to be, a very remarkable result follows from it. The pressure of the superheated rock upwards upon the given area, whose base is $l(1+e) \times 1$, equals the weight of the rock above it, and upon a unit of area will be $k(1+e)\rho g$ at the lower datum level, where g is the force of gravity. Now the pressure $k\rho g$ would be sufficient to bring the superheated rock to the upper datum level. Hence there is an excess of pressure equal to $k\rho g e$, which would serve to raise it to an additional height ke above the upper datum level.

This will account for the steady welling out of lava from a vent, or for its standing at a nearly uniform level in a crater, as in Hawaii. By our former investigation, which we see by (A) to be applicable to the present case, the average height of the mountains formed by the contraction would be

$$h = 2\,k\,m\,e.$$

Hence the lava would rise to the height $\frac{h}{2m}$, or to the surface which would be produced if the mountains were all levelled down.

This is much less than the height to which mountains might be thrown up, and leads one to ask whether there may not be here an explanation of the fact mentioned by Mr. Scrope, that although the peaks of the South American Volcanoes (which are the most lofty in the world) are frequently seen to emit vapour and ashes, we rarely hear of their giving issue to any great lava currents in recent times. The lavas of these mountains, he tells us, generally appear to have burst forth from lateral fissures on the flank of the lofty snow-covered volcanic peaks which crown the range. A distinction must be made between ebullition and a steady welling out of lava.

It must be remembered in these estimates, that no mountains in nature can reach the full height above the datum level which the formulæ give, partly because the curved contour gives a less altitude than the assumed triangular one, and partly on account of the full effect of elevation not being produced owing to friction and other causes, and also on account of subsequent denudation.

To revert to the connexion which Mr. Medlicott perceives between the supra-Nummulitic deposits of India and movements of elevation.

On the view which I advocate of mountain chains being produced by the shrinking of the earth's interior, the local pressure, caused by a fresh deposit disturbing the equilibrium in a certain region, in calculated to have several important consequences. In the first place it will originate a line of elevation along its shore-line or boundary, by tending to bend down, or fracture, the crust there, so as to present at that place inclined strata to the horizontal thrust. Secondly, the thickness of the rigid crust being increased by the new deposit, it would offer an impediment to the elevation of ridges beneath it, and throw the whole disturbance into the region just outside its boundary, in which case a little consideration will show that the whole newly-covered area would have a slight relative movement towards the disturbed area, and, as it were, nip it, so as to compress the anticlinals about their roots. In the meanwhile, sinking on account of its load of fresh deposit, the disturbed rocks would be pushed relatively *over* towards it. And thus, I think, we may account for what Mr. Medlicott notices as a general rule,[1] viz. the production of normal flexures, having their steeper sides towards the basin of depression; adding, "It would be valuable to know what light the abstract consideration of the case could throw upon the law thus indicated."

This also serves to explain the fanshaped arrangement of strata in certain mountain ridges.

We have from (2)

$$\Sigma (a) = k l e + \Sigma (b).$$

So that if any depressions, however produced, occurred below the datum level, the mountains would be increased by an equal amount. And since it is almost certain that such depressions, if of considerable size, would have displacements corresponding to them in the superheated rocks below (observing that $\Sigma (a) = \Sigma (\beta)$), there would be an additional rise of these rocks into the anticlinals. Since seas must occupy depressions, this may help to explain the usual proximity of volcanic vents to sea margins.

We may conceive such depressions as have been spoken of, to be sometimes formed by the weight of new deposits, which would then occupy them; but whether the depression of an area by the accumulation of fresh deposit would be compensated by an excessive elevation in its neighbourhood, seems to depend upon the amount of viscosity to be attributed to the superheated rocks. The more fluid they are, to the greater distance would the pressure be communicated, and the less would be the effect in the immediate neighbourhood, and *vice versâ.*

One word in defence of the theory of the elevation of mountains in consequence of the secular cooling of the earth, which I am happy to learn from Captain Hutton "is at present almost universally accepted by geologists as the cause of . . . the upheaval of mountain chains." He says that its effects must be completely absorbed by the much larger ones which flow from his theory.

If I have estimated the two at all justly, I have shown that the reverse is the case; for I have proved that if we suppose a stratum 500 miles thick, buried under 25 miles of crust, to have contracted since the crust became rigid on the whole as much as a slag would do in passing from a fused to a devitrified state (a reasonable supposition), this would give a mountain range of something under half a mile high on every hundred miles of surface, calculated in a manner similar to that employed in this paper. If only a part of the area was disturbed, the mountains would be higher.[1] And I have now shown how very much less would, in all probability, be the effect produced by the expansions suggested by our author. I have not had the good fortune to hear of the "many arguments" which have been urged against this generally accepted theory; but I think I have seen the solitary one mentioned by Captain Hutton somewhere before—that the earth has been warming instead of cooling since the glacial period. But to this I cannot accede. If we admit that the temperature of the surface as a whole is greater now than it was in a glacial period, it does not follow that the earth is not still cooling. If the surface were kept warmer than the interior, so that in descending the temperature decreased, it would prove it to be on the whole receiving heat, but so long as experiment shows that the interior is hotter than the surface, it must be losing heat[2]—not so rapidly certainly, as when the surface was kept more cool, but still losing heat.

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[1] *loc. cit.*, p. 45.

However, it is not probable that on the whole the earth was kept cooler during glacial periods than it is at present. It is more probable that the opposite hemispheres have been affected alternately with such periods,[3] and Captain Hutton, at the Antipodes, will do great service if he can elucidate this question. If glacial conditions were universal over the whole globe, it seems that we must look to a change in the condition of the Sun to account for them.

It may not be out of place to mention shortly the experiments referred to by Babbage and our author, respecting the expansion of stones when heated, and suggest some conclusions from them.

Lieut. Bartlett's experiments were made under the direction of Col. Totton in 1830, upon blocks of stone 94 inches long; the variations in length being measured for different temperatures between 6° and about 100° F. They appear to have been made under different states of atmospheric temperature during rather more than a year. The hygrometric condition of the stones was not taken account of. There were discrepancies observed in the rates of expansion in different experiments, and "it is probable that many of the discrepancies noticed were owing to the hygrometric[4] states of the stones," which were "not recorded."

Mr. Adie's experiments were made with great care upon rods of stone 23 inches long, of different kinds, both when moist and dry.

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[1] Cam. Phil. Trans., *loc. cit.*; and Geol. Mag., Vol. VII. p. 58.

[2] See Maxwell's Theory of Heat, p. 247.

[3] See a paper on "The Physical Geography of the Medeterranean during the Pleistocene Age," by W. Boyd Dawkins, M.A., F.R.S., in the "Popular Science Review," for April, 1873, p. 159.

[4] American Journal of Science, vol. xxii., p. 138.

He found that when moist many kinds of stone expanded more than when dry. For instance, for 1° F. he obtained for

	EXPANSION.
Sicilian White Marble ……	·0000078, moist.
	·00000613, dry.
Carrara Marble ……………	·00000662, moist.
	·00000363, dry.
Peterhead red Granite ……	·00000532, moist.
	·00000498, dry.

At 207° F. a rod of Greenstone, 23 inches long, contracted $\frac{1}{170}$th part of an inch by drying alone, the moisture which was allowed to evaporate being solely (as I understand the account) that absorbed by hanging in the room for three months.

Mr. Adie concluded that the average expansion of stone is very nearly the same as that of cast iron at ordinary temperatures.

Referring to Mr. Babbage's speculations, he considers that "little weight can be attached to such explanations of the great operations of nature; as there may be a vast difference between the effect of heat quickly communicated to the small pieces of stone on which we perform our experiments, and the necessarily slow diffusion of the heat through such a depth of strata as" Babbage "supposed;" viz. five miles.[1]

But I would go further, and inquire whether the internal heat of the earth would not produce contraction, rather than expansion; at least if it was sufficiently great to introduce metamorphism or any chemical change. The phenomena of jointing, of mineral veins, and of such faults as head to the downthrow, all point to a tendency in rocks to contract when deeply buried. And in considering Captain Hutton's theory, we must recollect that it is not the newly deposited matter which he supposes to expand, but the rocks upon which it is thrown down, which thereby become more or less hypogene.

It will be noticed that in this paper I have made no allusion to Mr. Mallet's new theory of the derivation of volcanic action from the conversion of the mechanical work of crushing the shell into heat, but have continued to regard lava as an extravasation of subjacent superheated rocks. I am anxiously looking for the full statement of that author's reasoning upon this question. But in the mean while I must say that the arguments I have at present read are not to my mind conclusive, first because I think his experiments do not run parallel with the facts of nature, and, secondly, because the crushing of the earth's crust must go on so slowly that the heat produced must be dissipated before it can have accumulated to the requisite amount. Other objections occur to me, but until the paper, as read before the Royal Society, appears in full, it would be premature to mention them. I have said thus much only because, in his otherwise complimentary note[2] on my paper on "The elevation of mountains, with a speculation on the origin of volcanic action," he has stated, that my views on the latter subject do not appear to him equally valid with my notions as to elevation.

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[1] Trans. Roy. Soc. Edin., vol. xiii., p. 370.

[2] See Mallet's Palmieri's *Vesuvius*, Introductory Sketch, p. 65, note.

V.—Further Notes on Crinoidea.

By John Rofe, F.G.S.

PLATE X.

During several years I have had frequent opportunities in my spare time of collecting and studying the Crinoidea, particularly those of the Carboniferous formation; but I have not had time, nor do I feel competent, to treat this subject fully in all its bearings. Perhaps, however, a few further notes on what I have observed in connexion with them, and in their relations with the recent as well as with those found in the several geological formations, may have an interest for some of your readers, or may be suggestive of further examination by some one better qualified by physiological knowledge for the inquiry.

Crinoidal Limestone, independent of the palæontological interest it possesses, has considerable geological importance, as from it may be deduced evidence of alternations in the depth of the sea in which the Crinoids flourished, sometimes, from their condition, suggesting great depth and clear water, and sometimes shallow water adjacent to a shore, or at an intermediate depth; and the great abundance of these remains, found under these different circumstances, make them worthy of more consideration in detail than they have yet received. Crinoids occur in most of the geological formations, particularly in the Palæozoic series; but they are found in the greatest profusion, both in number and in variety of species, in the Mountain Limestone; and I will therefore take this formation as the type, as most of the remarks I may make on it will apply to other strata in which Crinoids in any number occur.

In many places, particularly in the Pennine Chain in Westmoreland, Lancashire, Yorkshire, and Derbyshire, beds of this formation are composed almost entirely of portions of the columns or stems of Crinoids of different genera and species, varying from one to eighteen lines in diameter, but generally in short lengths.

In this mutilated condition these stems frequently occur in beds some feet in thickness, and so cemented together that they form a hard rock or marble, which takes a good polish, and is extensively used in this district for mantelpieces, tables, and other decorative purposes. One circumstance, however, is very remarkable, that amongst the innumerable portions of the columns, a calyx or head of any species is very rarely indeed found in the hard Limestone or marble rock itself, and what are found are generally in relief imbedded only partially in the upper surface of the rock and covered with shale or other parting between the Limestone beds. Those found with the arms, or with more than a few plates of the column, are, I believe, invariably in this condition. Sometimes the Crinoidal exuviæ are more or less mixed with shells and corals, and are less consolidated, and can be used only as a building-stone or for lime-burning; and in other cases the fossils are dispersed in beds of calcareous or agillaceous shale between the beds of Limestone. The heads, however, are occasionally found in considerable numbers,

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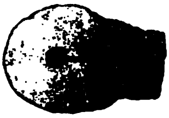

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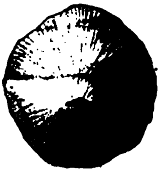

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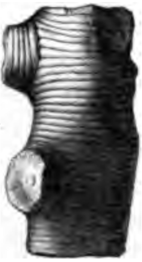

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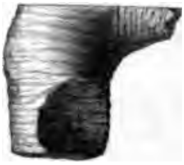

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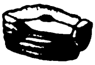

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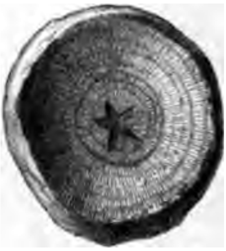

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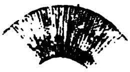

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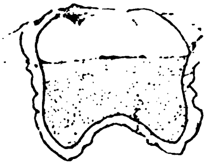

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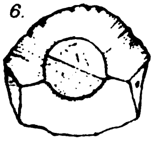

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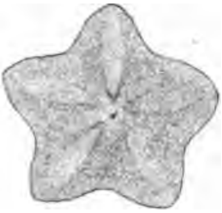

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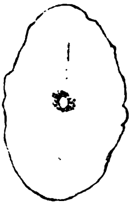

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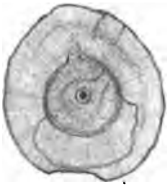

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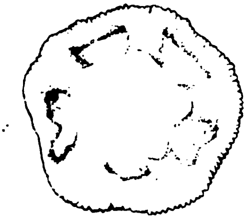

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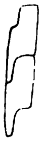

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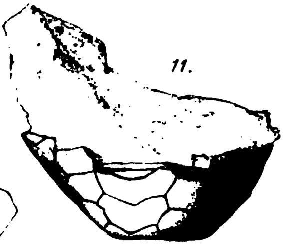

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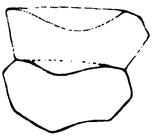

Mintern Bros imp.

illustrate Mr Rofe's paper on the structure of the Crinoidea.

detached and dispersed, in these interjacent shale-beds, the arms and columns generally entirely removed from them, or with exceptionally a very few plates left attached. The nature of the parting beds varies very much. In some cases they appear to consist principally of broken or small fossils, with a mixture of more or less argillaceous matter; and these beds are generally thin and friable, and may be called rotten, and in them many fossils are found which may easily be freed from the matrix whilst fresh from the quarry. In other cases the parting beds are sandstone, and in others argillaceous shale, these being generally the thickest.

These various conditions of the Limestone alluded to may arise from differences of the circumstances, both as to the depth of the sea under which the fossils were deposited, and the vicinity of land. Let us consider first the hard rock or marble. This, from the structure, appears to have been deposited in deep clear water, because the calcareous base or cement which holds the fossils together is so transparent and free from foreign matter that their organization may frequently be distinctly seen when the marble is polished. But in this marble, as above stated, very little besides portions of columns is found, although, from the thickness of the beds, they must have been a long time accumulating, and are evidently the product of many succeeding generations. If this be so, the question at once arises—What has become of the heads? In endeavouring to answer this, I must refer to some notes on the Crinoidea published in Vol. VIII. of this MAGAZINE, p. 241, in which it was suggested that all the ossicles and plates of these animals were invested in and held together by a membrane, which, in case of the death of the animal, would decompose, and thus allow the plates to fall asunder. The smaller surfaces in contact in the joints of the comparatively thin plates of the head, and of the arms and pinnules, would be the first so to decay, and the plates and ossicles would be dispersed before the decomposition of the larger surfaces between the columnar plates would permit their separation. These, however, would eventually fall into a mass, and be cemented together in a manner similar to the Coral Reefs described by Mr. Jukes,[1] and thus form a bed for a succeeding generation, which one after another would follow the same course so long as the circumstances under which the growth and deposit may take place remain the same; and the great thickness of some of the Crinoidal beds is sufficient evidence of long-continued repetition, and the beds so deposited would probably be similar in every respect as to the hardness and quality of the stone. But if from any cause the sea became more shallow, the nature and hardness of the bed would be different; and if currents brought the surface soil denuded from a neighbouring land, and deposited it on these animals, they would be destroyed by it and buried before decomposition took place, and they would thus be held together and preserved nearly or perhaps entirely whole, and the denuded soil would form the parting bed on the limestone, and thus cover and protect the fossil. That this has been the case is evident in many limestone beds, particularly in the case of the Upper Silurian beds of Dudley; and the [illegible] bed of the [illegible] formed by [illegible] as described by Lyell,[1] is a very apt illustration of this process.

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[1] Jukes and Geikie's Manual of Geology, 1872, pp. 388 and 389.

On the other hand, to account for the absence of these heads, it has been suggested that the Crinoids may have been the larval state of Pentacrinites, as the recent Pentacrinus Europaeus is of the Comatula, and that the columns were the remains left when the animal became free. But there is the serious objection to this theory that no such free Comatula has been found fossil in any formation in which the columns are abundant; and although this is only negative evidence, it acquires considerable weight when we find that the construction of the column is opposed to this suggestion, for they were evidently of [illegible], and probably of slow growth, increasing in diameter by an exogenous accretion, which may readily be observed from the columns themselves. At page [illegible] of the sixth volume of this Magazine, this mode of the increase of the diameter of the column was suggested from the fact that [illegible] attached to them whilst young and of small size became surrounded and invested by the new layers as added. The same mode of growth may be inferred from the side-arms, as the central canal of these branches off from that of the column whilst the columns are small; and as the diameter of this increases simultaneously with that of the side-arm, a cup is necessarily formed, increasing in depth as the column increases in diameter, so that the side-arm in a full-grown specimen appears to be inserted in a conical hollow or pit in the column (Fig. 1).

A periodical enlargement of the diameter of the column is sometimes indicated by the striæ on the faces of the joints, as in well-preserved specimens of some species these striæ bifurcate at certain distances as they recede from the centre (Fig. 3); and in weathered specimens, as well as in slices cut for the microscope, where metamorphic action has not effaced the structure, concentric rings of increase may frequently be traced, similar in appearance to those observable in the trunks of exogenous trees (Fig. 4).

When these animals grew under modified circumstances, as in a shallower sea, or in one disturbed by currents by which foreign matter might be mixed with them, but not in sufficient quantity to destroy them, the texture of the rock produced would necessarily be less uniform, and an inferior stone the result; so that, as a general rule, the deeper the water in which the Crinoids lived, or the further from land, the purer and harder would be the limestone deposit, whilst the reverse would be the case in shallow water or near land. By elevation of the coast and of the bed of the sea, a Crinoidal deposit or colony might be brought nearer to land, the denudation from which would form shale or sand-beds, as the case might be: if these again, by the oscillation of the sea-bed, should sink, further Crinoid deposits might take place; and a repetition of this process may have been going on for ages, as these deposits are found of great thickness, with occasional beds of shale or other partings, sometimes thin, and at others of considerable thickness. Further, to show that such oscillations have taken place, we have evidence that sometimes Crinoids, after partial decomposition, were present and exposed to wind on a sandy shore. Many persons, when walking on the shore of our own coasts, probably may have found the tests of sea-urchins blowing about, partially filled with the fine dry sand of the beach. If these are afterwards blown into a clay or muddy deposit, so common in estuaries, they would be filled up with the mud and buried. These, if found hereafter in a raised bed, partially or entirely fossilized, would present much the appearance of Fig. 5, representing the section of a *Rhodocrinus*, found in a shaly bed in the Mountain Limestone at Clithero; the lower part of the fossil being filled with fine sand (siliceous and calcareous), the upper part with mud very similar to the argillaceous calc-shale of the bed in which it was found: and similar cases are not very uncommon in bivalves and other fossils from these beds. In the Salt Hill Quarry at Clithero there is a thick bed of Crinoidal limestone, composed, as in the beds above named, almost entirely of portions of columns which have evidently been so exposed on a shore and subjected to a similar process. In almost every case the centre of the circular column to which the *fibro-cartilaginous* process is confined being decomposed and removed, the cavity has been partially, or sometimes entirely, filled up with sand, as in Fig. 6, the fine sand frequently containing, as in the case above alluded to, small portions of the channelled arms and of the minute pinnules or tentacles which fringe the arms of the Crinoid, thus demonstrating the disintegration of these parts of the animal before the columns entirely broke up. That part of the cavity which is not occupied by the sand is often full of transparent calc-spar.

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[1] Lyell's Student's Elements of Geology, 1871, p. 320.

Note on Variations in the Construction of the Columns.

In the paper above alluded to, in Vol. VIII. p. 241, of this Magazine, it was stated that a fibro-cartilaginous process ran longitudinally along the interior of the column, the rays, and of the side-arms, by which flexibility and the power of regulating the movement were given to these parts, and in illustration sections of a recent *Pentacrinus* are given, in which the membranes were manifest. It was also stated that the longitudinal fibres were differently disposed in different genera, in some cases surrounding and adjacent to the central canal, and in others in bundles or lobes round the canal, but towards the exterior of the column. The first arrangement appears to apply to round or elliptical, and the second to radiated pentagonal or polygonal columns, irrespective of their geological age.

In the last volume, Vol. IX., at page 387, Mr. J. E. Lee gives a section of a sub-quadrangular column of a *Cupressocrinus* from the Devonian formation, very similar in condition to the Chert specimen from the Mountain Limestone (Fig. 8, Pl. VI., Vol. VIII.); but in the Devonian the cast of the central canal is surrounded by four and sometimes, Mr. Lee states, five smaller columns, as shown in Fig. 3 in his paper. These I take to be siliceous pseudomorphs of the central canal, and of bundles of fibres similar to those shown in the recent *Pentacrinus* as Figs. 1 and 6, in the illustration to my paper as above, but which are not seen in the Chert specimen from the Mountain Limestone, as the fibres passed through the central screw-like portion, and not in bundles. In the Liassic Pentacrinites the fibro-cartilaginous lobes are disposed very similarly to those in the recent species, having a ring of pores round the central canal, and five lobes radiating from it, as in Fig. 7, whilst in the elliptical column of the Mountain Limestone *Platycrinus* (Fig. 8), and in the circular column of the Oolitic *Apiocrinus* (Fig. 9), the pores are distributed round the centre canal. I have also some portions of sub-pentagonal columns from Clithero, differing from those of other genera found in the Mountain Limestone in that district, which are generally circular in section. These vary in diameter from half an inch to more than an inch: a section of one is shown in Fig. 10. A thin section under the microscope shows the fibro-cartilaginous structure round the inner edge of the outer ring of the column, but in no instance have I found the central portion so perfect as to show the central canal or any organization. No head has been found which can be supposed to belong to these columns, a remark which applies to many other columns, and most particularly to the larger ones, frequently found abundantly in the Limestone. Probably this may be accounted for by the decomposition of the investing membrane above alluded to.

By the kindness of Mr. E. Hollier, I have procured pieces of columns from the Silurian formation at Dudley, including *Taxocrinus*, *Periechocrinus*, *Actinocrinus*, *Marsupiocrinus*, *Cyathocrinus*, and two columns undetermined, as they were without heads. Of these I have had slices mounted for the microscope, and find on examination that, although there appears to be a general similarity in construction with the round columns of the Mountain Limestone, as they are more metamorphosed by crystallization, the details are more difficult to distinguish. Some of them exhibit pentaphylloid sections of the central canal, as the *Taxocrinus* and *Cyathocrinus*, whilst the *Marsupiocrinus* shows a rosaceous section, the petals being wide and the divisions between them forming very acute angles; but I cannot satisfactorily make out the fibro-cartilaginous structure round the canal, though, from appearances, it is probable that it would be found by further examination with a great number of specimens.

Note on Euryocrinus (*Phillips*).

This Crinoid, which, from its rarity and the very imperfect state of the specimens hitherto found, is little known (neither the column, arms, nor dome having been recognized), is yet interesting from the peculiarity of the junction of some of the plates which form the cup. The only published notice of this genus which I have been able to find is in Phillips' Geology of Yorkshire, part ii. p. 205, and figured in plate 4, figs. 14 and 15, which appear to be drawn from two specimens in the Gilbertson collection now in the British Museum; the description given being merely, "Pelvic opening pentagonal; arrangement of plates like *Encrinus*, internal cavity very large." A third, and in some repects a rather more perfect specimen, from Clithero, is now in my hands, and from it, with the help of those in the Museum, the genus may be, in some respects, more fully described. Using M. de Koninck's nomenclature of the plates, it may be represented as having a base pentagonal and tripartite, small and pierced for a pentaphylloid central canal; subradials, four pentagonal, about as wide as high, one hexagonal, one and a half times as high as wide, which is the first anal plate. The base-lines of two of the pentagonal and of the hexagonal plate are not quite straight, but fit into the very obtuse angle formed by the junction of the plates of the base. There are five sets of primary radial plates, the third plate bifurcating, or sometimes the fourth, even in the same specimen, an irregularity which I have observed occasionally in the *Actinacrinus*. All the radials are about twice as wide as high, and are thick, and overlap on the lower side, falling over and hiding a recess in the plate under it, making the second and third radials appear to be concentrically curved both top and bottom, but at the back of the plates the joints are straight, as shown on the face as in Figs. 11, 11*a*, and 11*b* is a section of two plates showing the overlap. The joints are wrinkled on the face and at the angles rather more coarsely than is the case with many other Crinoids. This overlap must add to the strength of the unusually wide cup, and, so far as my experience goes, it is peculiar to this genus. Of the inter-radial plates one series consists of a single row standing on the anal plate; the others are irregular, but generally similar in arrangement to those of the *Actinocrinus*.

EXPLANATION OF PLATE XI.

FIG. 1.—Cross section and side view (Fig. 1*a*.) of a column and side arm, showing the branching of the central canal of the side-arm from that of the column, and on the side view showing the obtusely conical seat of a side-arm.

FIG. 1*b*.—Conical end of a side-arm detached from its seat.

FIG. 1*c*.—Cross section of a column, through two side-arms, showing the connexions with the central canal.

FIG. 2.—Side view of a column and side-arms, showing the gradual expansion of the plates of the column to suit the growth of the side-arm.

FIG. 3.—Portion of a section of a column, with bifurcation of the striæ. The central portion decomposed.

FIG. 4.—Portion of a large weathered column showing concentric rings of increase.

FIG. 5.—Section of *Rhodocrinus*, the lower part of the interior filled with consolidated sand.

FIG. 6.—Section of a column partially filled with consolidated sand, the remainder of the interior being subsequently filled with Calc-spar.

FIG. 7.—Section of a column of a Liassic Pentacrinite.

FIG. 8.—Section of an elliptical column of Mountain Limestone *Platycrinus*.

FIG. 9.—Section of a column of *Apiocrinus* (Oolitic), showing structure and rings of increase.

FIG. 10.—Section of a subpentagonal column from Mountain Limestone.

FIG. 11.—Side view of part of the calyx of *Euryocrinus*, showing arrangement of radial and inter-radial plates.

FIG. 11*a*, 11*b*.—Face and section of two radial plates of *Euryocrinus*, showing the overlapping of the plates.

V.—ON THE FORAMINIFERA AND SPONGES OF THE UPPER GREENSAND OF CAMBRIDGE.[1]

By W. JOHNSON SOLLAS, Associate of the Royal School of Mines, London, Scholar of St. John's College, Cambridge.

THE Upper Greensand of Cambridge occurs as a thin but very important bed, covering the eroded surface of the Gault, and blending upwards into the overlying Chalk-marl. It consists essentially of Chalk-marl, saturated with green grains of Glauconite, and crowded with a variety of fossils. The fossils in great part derive their origin from the Gault, out of which they have been concentrated by a natural process of levigation. At the time when the Gault sea was shallowing to its close, its submarine shores became eroded by a cold current flowing from the north, which bore away its lighter sedimentary clay, and left its imbedded fossils behind, to be subsequently rolled into the sublittoral deposit of the Upper Greensand. Thus it happens that in our neighbourhood the uppermost beds of the Gault are not to be found, and their only representative is this mere pebble-bed at the base of the Chalk. The rich fauna in our formation thus collected ready to the hand of the Palæontologist has been well worked out in its higher developments by Mr. Barret, Mr. Seeley, and various other observers. Of the *Protista* and *Cœlenterata*, however, some departments have been left all but untouched; and it is to the Sponges of the latter and the Foraminifera of the former that my paper refers. The Foraminifera occur abundantly, and in a rich variety, which seems to anticipate their more luxuriant appearance in the succeeding Chalk. The *Vitrea perforata* are represented by large forms of *Bulimina*, *Textularia*, and *Orthocerina*, which mimic truly arenaceous foraminifera by imbedding the siliceous and volcanic sand of the formation in their tests. *Cristellaria*, *Flabellina*, and *Frondicularia* are numerous, and of very fine growth; the *Frondicularia* sometimes attaining a ¼″ in length.

Rotalina is an abundant genus, so also are *Globigerina* and *Lagena*. The occurrence of this latter genus is noteworthy, for with the exception of one species, *L. apiculata* found in the Gault on the Continent, it has not been met with before below the Maestricht Chalk; in the Greensand, however, are several species, both of *Ectosolenian* and *Entosolenian* forms, of which one at least appears to be identical with a living species (*L. squamosa*) of the British seas. The large and numerous *Trochammina* and *Lituola* constitute a marked feature of the deposit. Of the same size as the Foraminifera, and associated with them, occur those characteristic green grains, whose origin in this formation has so long remained a subject for the merest conjecture. It is well known that off the coast of America, in the Ægean, and in some fossil deposits, green grains have been met with, distinctly derived from casts of Foraminifera. It was denied, however, that this was the case with the green grains of the

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[1] Read before the Cambridge Phil. Soc., March, 1873.

Upper Greensand formation.[1] Mr. Seeley[2] considered that they were mostly derived from wasted Volcanic rocks, and the numerous Volcanic erratics in the deposit seemed to lend some support to his conjecture. It was with the full conviction that this explanation was the true one, that I commenced an extended examination of these grains: it was not long, however, before I convinced myself to the contrary; and I now feel assured that the majority of the Glauconite granules are undoubtedly casts of Foraminifera. What one is at once struck with is the constancy in form of a number of these green grains, many of them constantly appearing as rounded tetrahedra, divided into projecting lobes by deep sulcations, which are generally lined at the bottom with white calcareous matter, serving well to define the limits of each lobe. While examining these forms, which roughly resemble *Bulimina,* one comes across others almost exactly similar to *Textularia, Globigerina,* or even delicate *Nodosariæ.* The grains resembling *Bulimina* in shape are similar also in size, and the same is the case with the Textularine, Nodosarine, and Globigerine forms. A section of one of the Bulimine forms frequently reveals the septa of its chambers, or something representing them, still extending to a greater or less extent inwards between their casts. The cracks and interstices of the coprolites of the Greensand are frequently injected with Glauconite, and this proves at least the possibility of a similar infiltration of the Foraminifera. Nothing, however, can be more conclusive than the occasional occurrence of a green grain which is still enveloped in the actual test of the Foraminifer whose chamber it has filled; here we have an undoubted case of a foraminiferal cast, and as regards the other green grains, their resemblance in size and shape to the Foraminifera accompanying them, and the appearance of many of them in section, lead us to the conclusion that they likewise owe their origin to Foraminifera.

The fossils we have thus far touched upon are probably contemporaneous with the Greensand itself. We now approach forms which are almost to a certainty derived from the Gault. The Coprolites of our formation, since they first received their name from Prof. Henslow, have passed through a somewhat eventful career. It was soon seen that they were not what their name implies, but the conjectures hazarded concerning their real nature fell somewhat wide of the mark, till Mr. Bonney published his valuable suggestions, by which was indicated the first step towards the elucidation of their origin.

The first fact of importance to be noticed in reference to the Coprolites is their marked connexion with previously existing, highly decomposable, organic matter. The polished surfaces of the teeth of *Otodus,* and of the palates of *Pycnodus,* are seldom or never encrusted with Coprolite; while their attached surfaces, to which were adherent softer animal tissues, are often completely imbedded in it. So, also, the sternal surfaces of Crustacea are buried in Coprolite, while this is seldom the case with the exposed surfaces of their carapaces. Other examples might be adduced, and, indeed, instances of the same fact multiplied almost without end. An additional argument on this point is furnished to us by analyses, which prove as a general result that organic matter still exists in the Coprolites, and that sometimes to the extent of 5 per cent. This makes itself evident by a smell of burnt horn when the nodules are heated, and by an odour like petroleum when they are dissolved. Not only in the Greensand, but in various other formations, this connexion of Coprolite with animal matter has been observed. It is strikingly noticeable in the Coprolites of the Red Crag, which have been derived from the London Clay, as those of the Greensand from the Gault. The palates of *Myliobates* are found in the Crag with their biting surfaces exposed and bare, whilst their attached surfaces are deeply incrusted with the Coprolite. So, also, with the teeth of *Carcharodon*, *Otodus*, and their allies; great balls of Coprolite surround their bases, but leave their blades perfectly clean. The incrusted Crustacea of the Crag are sometimes, however, completely inclosed in Coprolite. Analyses here, as in the Greensand, indicate the presence of organic matter.

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[1] Mr. Bonney, however, expressed his belief that many of the green grains would be found to owe their origin to Foraminifera.—Proceedings Geol. Assoc., vol. iii., no. 1, p. 5.

[2] Geol. Mag. Vol. III., p. 305, 1866.

Various other deposits contain nodules, which present characters more or less in accordance with the foregoing; but most interesting are the forms of the Lower Silurian of Canada,[1] which offer striking illustration of the fact we have been adducing. Here the phosphatic matter incloses *Lingula*, and fills casts of *Pleurotomaria* and *Holopea*. When heated it evolves ammoniacal water, with an odour like burnt horn. It almost always contains fluorine, and is sometimes surrounded on the exterior by iron pyrites, as also are some of our Greensand forms, a fact of significance in relation to the formation of these bodies, and strictly paralleled by the similar incrustations sometimes found around certain flints. Analyses made of these Silurian Coprolites always yield a large per-centage of organic matter.

This connexion between Coprolites and organic matter, which derives support from almost every fact which an investigation of these forms brings to light, furnishes us with a basis for a scientific definition of the term. The original meaning of the word Coprolite has, in reference to our Upper Greensand forms, long ago been washed out, and has become replaced by a perfectly distinct signification indicating the phosphatic fossils of our formation, or more restrictedly such of them as are of obscure or uncertain origin. The word is not a good one, but in face of its almost universal adoption one cannot hope to exterminate it. Flints are scarcely likely to acquire a name after some long Greek derivative, and Coprolites could hardly do so a second time. As one is not at liberty to choose a new name for these bodies, I propose to limit the application of the old one, and to call those bodies Coprolites which are produced by the phosphatic fossilization of organic matter, or of the immediate products of its decomposition. This does no violence to the obvious meaning of the word, which may as correctly be derived from "manure-stone" as from "fossil-dung."

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[1] Geological Survey of Canada, Edition 1863, p. 461.

A Coprolite thus serves as an index of pre-existing organic matter. and the task of the Palæontologist lies in definitely determining from what particular form this organic matter has in each particular instance been derived. With the fossil remains of Reptiles, Crustacea, Molluscs, or of Ventriculites, the question could never have presented more than a passing difficulty, but in certain other cases it has proved so far problematical that no satisfactory solution has been received up till very recently. I now propose to suggest an explanation which has lately been worked out, and which to my mind seems thoroughly to meet the case.[1]

The ordinary nodules impress one with their resemblance to sponge forms at first sight, some are rod-like, solid throughout, and attached at one end (*Rhabdospongia*), others cylindrical, with a central cloaca (*Bonneyia*), some again are cup-shaped (*Hylospongia*), others massive and lobose (*Acanthophora*), while some are branching, and others, finally, are incrusting. On closer examination of these nodules, one is frequently rewarded by finding, on the exterior surface, little pits of most definite characters. They are oval or circular in shape, and from $\frac{1}{8}''$ to $\frac{1}{20}''$ in diameter. Their circumference is often depressed into a concave border, across which pass regular striations, frilling it like the milled edge of a coin; sometimes these groovelets cease at the outer border of the little pit, at others they pass across it and wander for a long way until they are lost in the surrounding surface. The general character of these pits is strikingly suggestive of sponge oscules; still more so is their arrangement. Frequently they are grouped in sieve-like patches, sometimes they occur on one side only of the nodule, and occasionally they are terminal; in all these respects they find close parallels among existing sponges.

Besides these osculiform pits are numerous minute punctæ, which, in the Gault Coprolites, are seen to be the distinctly open terminations of fine canals. In the Greensand forms, however, these canals have become filled up since the nodules were washed out from the Gault, and their openings consequently appear as mere specks of a lighter colour than the surrounding substance. In other fossil sponges minute openings similar to these would be called "pores" by Palæontologists. These are all the observations one can make without the aid of instruments, but all the characters we have so far noted agree essentially with those of sponges, and not with anything else.

It now becomes necessary to examine the Coprolites more in detail—in sections and solutions under the microscope. When I came to do this, the necessity for preparing an extensive series of sections at once presented itself as a difficulty. Mr. Bonney, however, with his uniform kindness, placed at my disposal a large number of slides, on which are founded my succeeding observations.

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[1] Quart. Journ. Geol. Soc. Lond., Rev. O. Fisher, vol. xxix., p. 52; and W. J. Sollas, vol. xxviii., p. 397, and vol. xxix., p. 76.

The parts of a sponge which are most likely to be preserved are its siliceous spicules, and in most of the Coprolites of the formation spicules of one kind or another are to be found in greater or less abundance; a few simple needle-shaped spicules may generally be met with in any ordinary nodule, but in some particular forms they are especially numerous. *Rhabdospongia* has furnished some very fine examples; but, in the number and variety of their contained spicules *Polyacantha Etheridgii* and *Acanthophora Hartogii* far surpass all the rest. In both of these species hexradiate, quadriradiate, triradiate, and sinuous spicules are to be met with, and one of them is characterized especially by its porrecto- and recurvo-ternate forms. It is important to notice that the spicules are not only of indisputable sponge *forms*, but are sometimes also arranged in a manner which seems to indicate that they occur *in sitú*, and were not washed in during fossilization.

Various other bodies accompany the spicules in these sections, and in solution. Little spherules $\frac{1}{400}''$ $\frac{1}{200}''$ are not uncommon, and unless they are spicular in origin, it is difficult to conceive what else they can be but sponge gemmules. In some sections *Xanthidia* may be observed of the same species as those of the Chalk—*X. hirsutum, X. ramosum, X. tubiferum. Polycystina* of various genera also occur, and will shortly be described; forms resembling *Haliomma* may be noticed of somewhat common occurrence.

It is important to notice, as deciding the siliceous nature of the included spicules, that on dissolving the Coprolites in concentrated hydrochloric acid, an insoluble residue remains, which contains the spiculæ of the organism, together with its included *Polycystinæ* and the *Xanthidia* just enumerated. These may easily be observed under the microscope by suspending the residue that contains them in a little water, and placing a drop of this on an ordinary glass slide. The *Xanthidia* that may be present are really beautiful objects; floating in the water on the slide, they swim about freely in its currents, and catch with their claw-like processes at every little obstacle in their way, as though they were really alive.

Mr. Carter[1] has observed that in certain subspherous sponges the contractility succeeding death is often so great as almost to obliterate all their canals. That the organisms which furnished the Coprolites underwent great contraction after death is shown by the deep creases with which they are generally marked, while their contraction after *fossilization* is exhibited in quite a different manner by numerous sharply defined cracks. In consequence of this contraction, we should scarcely expect to find more than mere traces of canals now preserved, and as a general rule we do not. There are, however, some exceptional cases; for sometimes lighter streaks are seen drifting through the dark-brown Coprolite somewhat like the digitations of a river in its delta; and in single instances a vacant tube, circular in section, is preserved, into which canals may be seen opening on all sides from the surrounding matrix.

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[1] A descriptive account of four subspherous sponges, Arabian and British. J. H. Carter, F.R.S., Ann. Mag. Nat. Hist., ser. 4, vol. iv., p. 1, 1869.

On a review of the evidence I have just brought forward, few, I think, will be disposed to deny to a large proportion of the Coprolites, whose nature has for so long remained doubtful, a spongeous origin; their constancy in sponge form, the characters and arrangement of their well-marked oscules, their spicules, and the general connexion of coprolitic deposition with pre-existing animal matter, seem to force upon us the conclusion that to a large extent they owe their origin to sponges. The task now remains to determine the families and genera of recent sponges to which these fossils are most nearly allied; this will be a matter for laborious research, but so far as my investigations have yet carried me, I feel myself justified in pointing to the families *Esperiadæ* (Dr. J. E. Gray) and *Tethyadæ* (Gray) as those to which a number of these forms approach most nearly; while others hold most undoubted relations to the *Halichondridæ* (Gray).

In connexion with this subject, I may mention that spicules of *Geodidæ*, *Tethyadæ*, and other genera have already been definitely determined from the Upper Greensand of Blackdown.[1]

Besides this comparison of the Greensand fossil sponges with living forms, there also remains to be accomplished their correlation with the Coprolites of other deposits, a work only just entered upon; it is interesting to note, however, that so low down as the Lower Silurian of Canada, Coprolites have been found, one specimen of which, unusually rich in organic matter, contained small cylindrical bodies closely resembling the spicula of Sponges.[2]

Travelling upwards in the stratigraphical series, we find that as the close of the *Gault* is characterized by the occurrence of a large number of phosphatic nodules or Coprolites, so the close of the *Chalk* is distinguished by an abundance of peculiar siliceous nodules or Flints. There is, moreover, between these Flints and Coprolites so decided a parallelism, that in speaking of the Coprolites as the Flints of the Gault, one can scarcely be said to be indulging in metaphor. Both have been placed in the category of concretions, both alike have been formed by the mineralization of highly decomposable organic matter. It has been shown in both cases, that this animal matter has been largely derived from sponges; the Foraminifera and Xanthidia so characteristic of the Flints are found also in the Coprolites; and the Ventriculites which so generally accompany the former are not absent from the latter, since I have recently shown that several species of Ventriculites and Cephalites are far from uncommon in our deposit, and, indeed, that it is characterized by the very same species which appear later on in the Chalk strata (*V. tesselatus, mammillaris, cavatus, quincuncialis; Cephalites guttatus, capitatus*, etc., etc.).[3]

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[1] Fossil sponge spicules. Ann. Mag. Nat. Hist., ser. 4, vol. vi. p. 192, 1870, and Devon Assoc. Advt. Science, Lit., and Art, 26th July, 1870.

[2] Geological Survey of Canada, *loc. cit.*

[3] Quart. Journn. Geol. Soc., vol. xxix., p. 63.

The difference existing between Flints and Coprolites is merely this: that in the one case the basis of animal matter combined with a gelatinous hydric calcic phosphate, and in the other with a gelatinous silicic acid. In both cases after combination the organic elements carbon, hydrogen, and nitrogen were slowly dissipated, while the *mineral* matter remained behind as we see it now.

The *source* from which the Coprolites seem to have derived their calcic phosphate is to be attributed directly or indirectly to the waste of the volcanic rocks of the Lammermuirs and of other Northern localities. Its *means of conveyance* the cold current which subsequently eroded the Gault, and brought down in solution the ferrous and other silicates to infiltrate the Foraminiferal casts.

Once more passing upwards in the Geological series to recent seas, we come upon what seem to be Coprolites even now in process of formation, for it is asserted by Prof. Edwards,[1] that a large part of the guano of the Chincha Islands in no way bears any resemblance to the excrement of birds, but, on the contrary, is a stratified deposit of Sponges and various Protists still in process of fossilization. The anchors of ships weighed there are said to frequently bring up guano from the bottom of the ocean, and microscopic analysis has shown that the insoluble parts of the deposited guano consist of sponge skeletons, *Diatoms* and *Polycystinæ*, far too well preserved to allow us to conclude that they have passed first through the intestines of Molluscs, and then through those of Birds. However this may be—and one would not wish to put too much weight on these statements till they have been abundantly verified—we cannot but feel that the dignity of excrement has already been somewhat detracted from; and while on the one hand the sponges have recently received a great elevation in rank in the Zoological kingdom, they have on the other increased somewhat in importance in the Geological world.

NOTICES OF MEMOIRS.

I.—ON THE GEOLOGY OF THE EASTERN PORTION OF EUROPEAN TURKEY.

DIE GEOLOGISCHEN VERHÄLTNISSE DES ÖSTLICHEN THEILES DER EUROPÄISCHEN TÜRKEI. Von Professor Dr. FERDINAND VON HOCHSTETTER. 2^te^ Abtheil. Jahrbuch der K. K. geologischen Reichsanstalt, 1872. xxii. Bd. 4 Heft.

STRABO mentions as the principal mountain ranges of Roumelia the Bertiscus, Scardus, Orbelus, Scomius or Scombrus, the Rhodope, and the Haemus. He also asserts that these ranges reach in a straight line from the Adriatic to the Black Sea, which notion was until recently expounded in all the handbooks of geography, treating these ranges, as a central mountain ridge, and a continuation of the Eastern Alps. Only lately the discoveries of Boué, Viquesnel,

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[1] Essex Inst., Salem, Mass., Bull. vol. i., p. 11, 1866. Ann. Lyc. Nat. Hist., New York, vol. x., p. 225, 1871. Quart. Journ. Micr. Soc., new ser. no. xlv., p. 71.

Grisebach, Lejean, von Hahn, and lastly von Hochstetter, disposed of this hypothesis. Grisebach proved that the Bertiscus corresponds with the Albanian Alps, the Scardus with the Schardagh of the present day. The Haemus is the Balkan, the Rhodope still bears the same name, and there is only the Orbelus and Scomius left: the former most probably corresponds with the highest western mountains of the Rhodope, with the Perim and Rilo Dagh; and the latter is the Vitos. The Vitos rises in the centre between the Balkan and Rilo mountains in the heart of Turkey. The mighty mass of syenite, of which it is composed, rises on a nearly circular basis from the plain of Sofia to an absolute height of 2300 metres. From this lofty mountain mass the four chief river-systems of European Turkey take their rise—the Marica, Struma, Isker, and the Morawa. Four mountain-systems also meet here, namely, the Balkan, the Rumelian Hills, the Rhodope, and the Upper Moesian Mountains. The Vitos may rightly be called a syenite massive, for the greatest portion of it is composed of this rock. On the south side of the Vitos, near Kovacevci, we only find syenite, which contains a considerable portion of magnetic iron-ore. The northern slopes of the mountain mass, towards Sofia, is almost solely composed of a fine-grained dark melaphyre-like rock, which is evidently connected in the east with the augite porphyries of the northern portion of the Brdo mountains, and in the west with the extensive igneous district of the Lülün and Visker mountains. The syenite of the Vitos is normal, sometimes coarse-grained, and contains, besides reddish orthoclase, a white triclinic felspar, and the hornblende varies in colour from black to green. Quartz, magnetic iron, titanite, and needles of apatite, with abundance of black mica, occur as accessory minerals. In the neighbourhood of Samakov, where the syenite is much decomposed, a rude iron industry has sprung up. The decomposed mass, which contains magnetic iron ore, is washed, and the latter mineral melted in furnaces of very primitive construction.

The plateau of Samakov (960 metres) is separated from the valley of Dubnica (940 metres) and Radomir (618 metres) by ranges of hills, which are chiefly composed of old crystalline rocks, which connect the Rilo mountains with the Vitos. The principal rock of this range is coarsely fibrous grey gneiss, which often assumes a porphyritic texture, containing large lumps and crystals of felspar. Granite dykes and veins are frequently met with, and alter sometimes into a black micaceous hornblende rock and into granular amphibolite.

West and south-west of the Vitos, Hochstetter discovered a system of stratified rocks, which repose on the crystalline base, and stretch towards Dubnica and Radomir in a north and north-westerly direction, most probably as far as the valley of the Nisava, which river divides these rocks from the corresponding ones on the other side of the valley, which belongs to the Balkan range. Hochstetter was able to distinguish three distinct systems of strata in this district. At places, where the crystalline basis is exposed, we find resting directly on it (*a*) a system of more or less great thickness of red and white quartzose sandstones, and in close connexion with it variegated friable marly shales, alternating with white and brown sandstone beds, and with a few layers of limestone and dolomite. Resting unconformably on this is (*b*) a system of grey and white, rarely reddish, dense limestones and dolomites of enormous thickness, which at once remind one of the character of the limestone Alps. This formation composes the Golo Brdo Mountains, the Koniavo, and Vrbina Planina. The Struma river has broken through this range (12 to 1500 metres) near Köstendil. Beyond this defile this system of rocks extend farther north in the direction of Trn and beyond.

Placed in comparison with the limestone series of the Alps, the lower marl and sandstone series would, perhaps, represent Lower Trias (Werfener Schiefer), partly even the Permian (Rothliegendes), whilst the upper portion of it would correspond with the Middle and Upper Trias. But more probably (and a few although indistinct fossil remains corroborate it) this system of rocks should be compared with the northern Carpathians; in this case the quartzite, sandstones, and marls would represent the Keuper, the beds and limestones above Kössen beds (*Avicula contorta* zone), whilst the principal mass of limestone and dolomite would belong to the Jurassic and Cretaceous series. The range of a third system (*c*) is less doubtful, in the valleys and extending far on the north-eastern and eastern slopes of the Koniavo, the Vrbina Planina and northwards reposes unconformably on the limestone beds a system of strata of great thickness, which is composed of greyish-brown shaly sandstones and alternating clayey marls. Sometimes limestones are found with this series. The general aspect of the low hilly country formed by these beds much resembles the character of the Gosau formation of the Alps, or of the Carpathian sandstones, and no doubt they belong to the Cretaceous series, most likely to the Gault, which is well developed in the Balkan. Fossils were obtained only in two places, in the Bunovo Valley and near Trn, amongst them *Ammonites mammillatus*, Schloth., a true Gault species.

Analogous to the eruptive district lying between Burgas and Tamboli, described in the first part of this paper (reviewed in GEOL. MAG., 1871, Vol. VIII., p. 466), the igneous rocks of the Lülün and the Vitos are also basic rocks of the character of melaphyres, augite porphyries, and augitic oligoclase or labrador porphyries, which are accompanied by widely-spread stratified tuffs, conglomerates, and amygdaloids. West of the Vitos, and inclosed by it and the Lülün and Visk mountains, lies a small Tertiary basin, in which is deposited a bed of Brown coal, which is exposed at several places.

Between Vranja and Leskowac, the Morawa high crystalline mountain ranges (2000 metres) rise up, which in S.E. are connected with the Rhodope, and in S. with the Schardagh and Pindus systems. These ranges consist of gneiss, mica schists, and old clayslate. Numerous rhyolite and trachyte eruptions in connexion with much tuff forms another important character of this district. Professor Hochstetter gives in his valuable paper, not less than in the first part of it (1871), a detailed description of his many tours and excursions over the country with accompanying sections and a new geological map, the basis of which is entirely new and compiled by him from the surveys of Austrian officers, the engineers of the Ottoman railroads, and himself. He also appends a valuable list of heights in the Eastern portion of European Turkey.

C. L. GRIESBACH.

II.—ON THE GLACIAL AND CHAMPLAIN ERAS IN NEW ENGLAND.

By J. D. DANA.[1]

DR. DANA'S observations go to show that the Glacial period was an era of transportation by ice, with the deposition from the glacier of only a small part of the drift, including the Boulder-clay; while the early part of the Champlain period, to which he refers the time of melting, was an era eminently of deposition, and also of further transportation by moving waters and floating ice. He regards the Glacial period as of great duration, and expresses the opinion that one foot a week was the average rate of the movement of the ice, so that 10,000 years would be required to carry a boulder one hundred miles.

The general course of the movement over New England was to the south-east. In the northern part of this country he estimates the ice to have had a thickness of from 5,000 to 6,500 feet, and in the southern part an average of 2,700 feet. The pressure must have been immense—6,000 feet corresponding to at least 300,000 pounds to the square foot. Under this great pressure there was not only abrasion of the rocks beneath by the ice armed with stones in its lower surface, and also a crushing of softer kinds from mere pressure, but, besides, a breaking and crushing of the ice itself against the obstacles in its course, and also a pressing of the plastic material down among all the stones and gravel or sand; and thus it was able to envelop and take up into its mass the loose material. Further, the ice of the ice-mass above must have been forced down into all openings and crevices in the rocks, so that the glacier, as it moved, had tremendous power in abrading, and must have made boulders and gravel in immense quantities.

The valleys of New England have throughout a high terrace along their sides, of material generally stratified, which belongs to the Champlain formation, being merely the old alluvial deposits of this era terraced in consequence of a general rising of the land, when what he has called the Terrace or Recent epoch began. He is of opinion that in the Quaternary period of North America over the higher latitudes, there was an upward movement for the Glacial era, a downward movement below the present level for the Champlain era, and an upward one for the Terrace era.

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[1] Reprinted from the "American Journal of Science and Arts," vol. v., March, 1873.

REVIEWS.

I.—EVOLUTION OF LIFE. By HENRY CHAPMAN, M.D. 8vo. pp. 193. (Philadelphia, 1873: Lippincott & Co.)

IT is somewhat astonishing to remark the amount of misconception that generally prevails in regard to the writings of Darwin even among many would-be scientific individuals, and how very general the notion is that his main object has been to prove that men were descended from monkeys. But this astonishment dwindles away when we reflect how few have read his works with care, and how many who have read anything of them have read with preconceived opinions, and in a spirit of antagonism, disregarding in a great measure his careful array of facts, and attempting to ridicule his cautious inferences and deductions.

The variation of species, and natural selection or the survival of the fittest in the struggle for existence, are Natural History facts, and the consideration of these facts as brought prominently into notice by Darwin, has led to the doctrine of the Evolution of Life being regarded as the "Fundamental Truth of Biology." When, therefore, we hear the subject treated as chimerical and purely imaginary—a tale of fairy land wherein a flea might be transformed into an elephant, or an antelope, by constantly stretching its neck, might become a giraffe—we feel how greatly misunderstood and misrepresented the doctrine has been. This may arise from the mistaken notion that it would allow any one form of life in process of time, and through many generations, to develop into any other. When we look, however, upon the forms of life as the modified descendants of pre-existing organisms, we consider their relationship one to another much in the same way as we consider that of our own species individually. The relationship we bear to one another is sometimes near, sometimes very distant, so that when in one case we trace our descent only one grade removed, in another we are connected only through distant generations. It is the same with the different forms of life; in each branch, starting from one type, variation has set in, but while some forms have changed others have remained more or less stationary or altered in a different ratio, so that constantly divergent forms are derived from the original type, and these divergent forms must not be confounded as being derived one from the other, but only as being derived from the same parent source.

Of course it is a great question as to how far the theory of Evolution may be successfully applied, but no earnest student of Nature can long adhere to the very unphilosophical notion of a series of special creations, and when we hear otherwise well-informed persons talking of the profanity of the Darwinian theory, and insisting on the *literal acceptation* of the Scriptural account of the Creation, we cannot help reminding them that, notwithstanding the undoubted figurative language in which the Mosaic Cosmogony is recorded, that description is really far more consistent with the doctrine of Evolution than with one which requires constant special creations of different forms of life throughout time. So hard is it to realize the truth of the old adage that "Fact is often stranger than Fiction."

This may appear rather a long prelude to our notice of Dr. Chapman's book, but, perhaps, it may not be altogether useless, as the work before us is not a record of new facts, but a condensed view, intended for popular reading, of the most important generalizations in reference to the structure of plants and animals, their petrified remains, and mode of development, and showing how the doctrine of the Evolution of Life is borne out by the facts of Botany, Zoology, Geology, and Embryology. It would be out of place here to discuss the questions raised in all these departments of natural science: we must confine ourselves to the geological section, and, indeed, the results of palæontological investigation have, perhaps, the most important bearing on all questions of Evolution.

This bearing is discussed by Dr. Chapman in his section Geology. He gives a brief sketch of geological reasoning, and points out the liability of error into which many observers fall, from applying generalizations drawn from limited data to the whole world. This is particularly the case in determining the relative ages of rocks in widely distant areas. This, however, does not affect Palæontology when looked upon in a purely zoological light, or when brought to bear upon the subject of Evolution. Drawing attention first to the life of the Silurian period, Dr. Chapman points out that the forms of life are the most simply organized of the respective divisions of the animal or vegetable kingdom to which they belong. Thus the Crinoids and Starfish were the oldest of the Echinodermata, the Brachiopoda of Mollusca, the Entomostraca of Crustacea, the Worms preceded the Insects, and the Fucoidæ were the earliest types of vegetable life. In the Old Red Sandstone period we find remains of Fish, a few Ferns, Lycopods and Conifers; the Fishes are of the Shark tribe and Ganoids, not so highly organized as the Teliosts of the present day; and the Ganoids he considers to be the common stock from which the Teliosts and Batrachia diverged. In the Carboniferous period we find Ferns in great variety and Lycopod-like plants of luxuriant growth; the Batrachia first appear, together with the Centipedes, the May-fly, Locust and Beetle orders among Insects. In the Permian rocks remains of the simplest reptile, the *Proterosaurus*, occur; while in the Triassic period we have not only Batrachia and Reptiles, but Birds and Mammalia (Marsupials). Among the Birds the *Brontozoon* of the Connecticut valley must have been four times as large as the Ostrich. Dr. Chapman observes that the existence of such large birds at this period is in harmony with the view of the Reptiles being the progenitors through the Ostrich family of the Birds; while the fact of both Birds and Mammals appearing about the same time confirms the theory that they are the diverging stem of a common stock, the Reptilia. In the Jurassic period we find a great variety of Reptiles: the *Ichthyosaurus* and *Plesiosaurus* are considered to unite in their organization reptilian with batrachian and piscine characters. The *Campsognathus*, a bird-like reptile, and the *Archæopteryx*, a reptile-like bird, tend to bridge over the gap between existing reptiles and birds. The Cretaceous period yields, besides gigantic reptiles, fishes and plants more modern in appearance; while the Tertiary period offers, besides many mollusca closely allied to the recent, others identical. It is essentially an age of Mammals, Palms, and Exogens. The Mammalia are particularly interesting to the Evolutionist, yielding the intermediate forms which bind together the Rhinoceros and the Horse, the Hippopotamus and the Pig, etc.

While a study of Palæontology shows that higher and higher forms of life appeared from time to time,—that the oldest rocks yield the simplest types, and the newer rocks the most highly organized,—it also shows that each large group had, as it were, a maximum development, and gave way or yielded up its sway to the higher forms which succeeded, of which Man is the last. Nevertheless, although many forms became extinct, we have still the modified descendants of all classes, and a few among the lower ones which show little or no variation from the earliest types.

Such are the results of Palæontology. Into the other sections, Zoology, Botany, Embryology, and Natural Selection, we need not go; we believe Dr. Chapman has given a very fair idea of the facts which those subjects furnish towards the doctrine of Evolution. The Anthropological Section is a little out of our line, but we cannot be uninterested in the theory that man has descended from an ape, which Dr. Chapman accepts, although he finds it impossible to designate any particular ape as the remote ancestor. He gives a plate of the faces of men and monkeys, and no doubt there appear to be many ape-like men, and many man-like apes. He remarks that "the more probable theory of the relationship of man to the Anthropoid Apes is that they are very distant cousins, the posterity of a common ancestor of some extinct form, whose remains have not as yet been discovered." In regard to the birth-place of man, it is involved in obscurity; but Dr. Chapman leans to the idea that the sunken land called Lemuria by Dr. Sclater, which once existed where the Indian Ocean now rolls, might have been the birth-place of the human species: and we cannot help suggesting what happy and poetical ideas of a deluge might be started on such a notion. Poetical ideas, however, will not do, as Dr. Chapman remarks; for instead of a Golden Age, from which man has fallen, the explorations of the last forty years have proved that the first age was one of Stone. However, we must leave these questions—we cannot at present grasp the idea of the Anthropoid origin of man—but we may rest comforted that whatever is the true history, the *descent* of man has indeed been an *ascent*.

H. B. W.

II.—BY FLOOD AND BY FELL; OR, CAUSES OF CHANGE, ORGANIC AND INORGANIC, IN THE MATERIAL WORLD. By E. CHARLOTTE EYTON. (8vo. pp. 127. London: G. T. Goodwin.)

AS an attempt to popularize Natural Science, and particularly Geology, this book deserves praise, but while it may serve to luce "men and women, more especially young men and women, take an interest and to examine and search for themselves into the uny wonderful phenomena which we see all around," yet there is many instances a want of scientific precision which is apt to lead erroneous ideas, and the names of the fossils are often mis-spelt. iese are faults which we cannot but regret to see, and they prent our commending the book so highly as we should have liked to ; we hope however they will be carefully removed before the sue of the second edition.

I.—A HANDY-BOOK OF ROCK NAMES, WITH BRIEF DESCRIPTIONS OF THE ROCKS. By G. HENRY KINAHAN. 8vo., pp. 139. (London: Robert Hardwicke, 1873.)

WE heartily recommend this little work by Mr. Kinahan. Petrology is far behindhand in this country, as we are constantly minded when we want a work of reference. Cotta's Lithology, as anslated by Lawrence, was a great boon; but there is much to be me yet.

Mr. Kinahan's book is divided into three parts—I. A Classified ble of Rocks; II. and III. Descriptions of the two orders Ingenites id Derivate Rocks. Under Ingenite rocks are included all the true neous, intrusive, or irruptive rocks, whether they are still in their iginal state or have been subsequently affected by metamorphic tion, as also the metamorphosed sedimentary rocks; since all these ive been formed within or below the surface of the earth. Under erivate rocks are included all the sedimentary rocks, and those of ganic origin.

The author has adopted Dana's suggestion in using the ending e for rock names, so as to distinguish the rock masses from the inerals, such as Augite, Steatite, etc. Hence we have Augyte, enyte, Dolomyte, etc., but Granite is still spelt in the old way— e should like to know the reason why!

A very useful and important feature in this work is the number of cal names explained—but there is much to be done in rendering is part more complete, even Page's "Hand-Book" will add some. serious omission we have to call attention to, and that is the want a complete index to the volume. This is not by any means furshed by the classified table, without page references, and the index those names not mentioned in it.

7.—TABLE OF BRITISH STRATA, SHOWING THEIR ORDER OF SUPERPOSITION AND RELATIVE THICKNESS. For the Use of Schools. By H. W. BRISTOW, F.R.S., F.G.S., Director of the Geological Survey of England and Wales. (London: Chapman and Hall, 1873.

N our January Number this year we noticed a Table of British Sedimentary and Fossiliferous Strata prepared by Mr. Bristow; e have just received a second one, which is of a different character, ing in the form of a coloured diagram. This diagram shows in a ry clear and distinct manner the relative thicknesses of the rocks, not in one column only, but the relative thicknesses of each subdivision in columns parallel to the groups and systems and other larger divisions. Thus we have the Upper, Middle, and Lower Lias shown in one column, with the other minor subdivisions of the British rocks; adjoining this the Lias is coloured as a whole; in the next column the whole Oolitic series has one colour; then the Lower Mesozoic period; then the Mesozoic; and lastly the Neozoic cycle. The minor subdivisions of the Carboniferous period are shown with their variations in different localities, and some additional notes are given on the margin of the diagram in regard to this and some of the other series of rocks.

We may unhesitatingly call it the best pictorial table of strata we have seen; it is a little over four feet in length and not quite two feet in breadth. We consider the essential feature of it, namely, the exhibition of the relative thicknesses of the rocks, as a very important one, especially in a school diagram, as too often exaggerated notions of the importance of a series may be obtained from a consideration of its sub-divisions. Thus, to cite a single illustration, but few are aware that the Lower Silurian rocks are thicker than the entire mass of the Secondary strata. Such facts however get fixed in one's mind, by the aid of a Diagram, more easily than by any other means.

V.—PHYSICAL GEOGRAPHY. By SYDNEY B. J. SKERTCHLY, F.G.S. 8vo., pp. 196. (London: Thomas Murby, 1872.)

THIS little work, the first of Murby's "Series of Science Manuals," treats the subject of Physical Geography in a simple and elementary way, and yet with a completeness that will render it very useful as a class-book for schools, and as a manual for junior students. There is considerable freshness in the style in which the subject-matter is put before the reader, and some original observations are contained in it. In regard to the adoption of the term "Transtratic," which the author proposes to apply to such springs as return their water to the surface at points more or less distant from the source whence it was derived, we offer a gentle protest against it. It seems to us not sufficiently in accordance with the motto of the work, *Utile et dulce*; it sounds harsh, and we should prefer Transmittent, or even Interstratic, as being equally suitable, and as being somewhat more euphonious into the bargain.

VI.—PRE-HISTORIC MAN IN BELGIUM. By M. E. DUPONT. L'Homme pendant les ages de la Pierre dans les environs de Dinant-sur-Meuse. 2^{me} edit. 8vo. pp. 250. (Bruxelles: C. Muquardt. 1873.)

THIS work is devoted to the discussion of the earliest known indications of Man in Belgium, when he was the contemporary of the Mammoth, Hyæna, and Cave-bear. Living then by the chase, and inhabiting caves, he has left numerous remains, which form materials for tracing out his history, and show that his manners and customs and industry, taken altogether, were somewhat analogous to those of the Esquimaux of the present day. Finally, M. Dupont traces out the discovery of the use of metals and the influence of foreign civilization on the progress of man in Belgium.

He refers first to the researches of others in this same field, and particularly to the early observations of Schmerling, on the caverns of Liège. He then gives, in Chapter I., a general *résumé* of the geology and palæontology of the Quaternary Period, treating of the origin of caverns, the changes of climate, the extension of glaciers, and the different forms of life. Chapter II. is devoted to "Man during the age of the Mammoth," wherein he brings forward the evidences furnished by the caverns of Montaigle, Lesse, and Goyet. Chapter III. treats of "Man during the age of the Reindeer," and Chapter IV. of "Man during the age of polished Stone.

The work is accompanied by numerous engravings, four lithographic plates, and a large table showing the caverns which have yielded human bones, flint implements, and other indications of man, and mammalian remains of the Stone Age, which Age is divided into that of the Mammoth, that of the Reindeer, and lastly that of polished Stone.

REPORTS AND PROCEEDINGS.

Geological Society of London. — April 9th, 1873. — His Grace the Duke of Argyle, K.T., F.R.S., President, in the Chair.—The following communications were read:—1. "Lakes of the North-eastern Alps, and their bearing on the Glacier-erosion Theory." By the Rev. T. G. Bonney, M.A., F.G.S.

The purpose of this paper was to test, by the Lakes of the Salzkammergut and neighbourhood, the theory of the erosion of lake-basins by glaciers, which has been advanced by Prof. Ramsay. The author premised—1. That an extensive glacier could not exist without a considerable area to supply it. 2. That under no circumstances could a glacier excavate a cliff of considerable height (say 1000 feet) approximately vertical. 3. That owing to the proximity of the regions, a theory of excavation which applied to the Western and Central Alps ought to be applicable also to the Eastern Alps. He then proceeded to examine a number of lakes in detail. The Königsee lies in a remarkably deep, steep-sided valley terminated by a cirque, with cliffs full a thousand feet high, and has no large supply area behind. The Hallstadtersee is similarly situated, has a cirque at the head, and two lateral valleys nearly at right angles to the lake, up which arms of it have formerly extended. These are not likely to have furnished glaciers which could have excavated the lake; and above the cirque there is no large supply area. The Gosauthal consists of lake-basins separated by valleys of river-erosion. The Fuschelsee and Wolfgangersee, on the south side of the Schafberg, are separated by a narrow sharp ridge of hills, incapable of nourishing glaciers large enough to grind them out; there are no signs of glaciers from other directions having eroded them The Mondsee and Attersee (once one lake) on the north lie under the steep cliffs of the Shafberg, which could not have nourished a large glacier; and the ridge of the Schafberg is too sharp to admit of the supposition that a great glacier, coming from the south, has passed over it to excavate the lake; yet the Attersee, in a position least favourable to glacial action, is the largest and deepest lake in the Salzkammergut. The head of the valley in which these lakes lie is really among low hills, in the direction of the Austro-Bavarian plain. The Traunsee was shown to give no evidence in favour of a theory of glacial-erosion. Since then these lakes either had at their heads preglacial cirques (the very existence of which was incompatible with much erosive power on the part of a glacier), or were beneath sharp and not greatly elevated ridges of rock, the author concluded that they had not been excavated primarily by glaciers. He considered a far more probable explanation to be, that the greater lake-basins were parts of ordinary valleys, excavated by rain and rivers, the beds of which had undergone disturbances after the valley had assumed approximately its present contour. He showed that the lakes were in most cases maintained at their *present* level by drift; and that, while in a region so subject to slight disturbances as the Alps, positive evidence for his theory would be almost impossible to obtain, no lake offered any against it, and one, the Königsee, was very favourable to it.

2. "On the Effects of Glacier-erosion in Alpine Valleys." By Signor B. Gastaldi. The author described the occurrence in the valley of the Lanzo and other Alpine valleys, at heights between 2000 and 3000 metres (6500 and 9700 feet), of large cirques, in two of which, in the valley Sauze de Césanne, the bottom was occupied in the autumn by glaciers reduced to their smallest dimensions. The author noticed the various rocks in which these cirques were cut, and expressed his opinion that they are the beds formerly occupied by glaciers, the power of which to excavate even comparatively hard rocks, such as felspathic, amphibolite-, and chlorite-schists, he considered to be proved. The author then referred to the mouths of the Alpine valleys opening upon the plain, which he described as being generally very narrow in proportion to their length, width, and orographical importance; and he pointed out that in the case of the valley of the Stura, at any rate, the outlet of the valley has been cut out by the river. This peculiarity he accounts for by the fact that whilst the calcareous and felspathic rocks are easily disintegrated by atmospheric action, certain other rocks, such as the amphibolites, diorites, syenites, amphibolite-schists, euphotides, serpentines, etc., resist atmospheric denudation; and he indicated the peculiar distribution of these rocks in the region under consideration, by reason of which portions of them occupied the points which are now the mouths of the valleys.

Discussion.—Mr. Drew illustrated the subject by a comparison with the Himalayas, where similar cirques to those in the Alps exist, and are still occupied by glaciers. The arena of the amphitheatres only is occupied by the ice, and the almost vertical slopes are covered with an accumulation of snow, which helps to feed the glaciers. He was not acquainted with any cirque in the Himalayas in which glacial markings are entirely absent. The bottoms of the cirques were not unfrequently lake-basins.

Mr. Blanford instanced a cirque beneath Schneehatten, in Norway, in which a glacier terminated. At the other end the lake was bounded by a hard ridge of rock. The rocks around were moutonnéed, and glaciated.

Mr. Koch had studied the effects of glaciers in Switzerland, but had been unable to ascertain the extent of their excavating power. Where the planing effect of glaciers in ancient times was visible, it appeared to him to have acted in straight, and not in curved lines. He disputed the fact of diorites and serpentines resisting the action of the weather. He had made some experiments on the powers of different rocks to resist the influence of frost and weather, and had been surprised to find how different were the effects under different conditions.

Prof. Ramsay stated that he had not heard any objections now raised to his theories which he had not already answered, or attempted to answer in print, in the *Philosophical Magazine* and elsewhere. The strictures of both Sir Roderick Murchison and Sir Charles Lyell were, so far as he remembered, nearly similar to those to which he now had to reply. He pointed out that at the time when Scandinavia and the greater part of the north of Europe, as well as the Alps, were covered with ice. the circumstances were entirely different from what they were at a later time, when there were merely a few local ice-centres, from which glacier-erosion might radiate. When there was any thing approaching to a general ice-coating, the erosion must have been enormous, especially at spots where there were already pre-existing valleys, in which, of course, the ice would have been thicker than elsewhere, and where, consequently, its grinding powers would have been far greater, and have added much to the work of the more ancient rivers. He inquired of Mr. Bonney what must take place at the termination of any glacier. There could be no erosion by the glacier anywhere beyond the point to which it extended; but where it existed some erosion must take place, and a basin of greater or less depth thus be ground out by the alternating advance and retreat of the glacier. A river flowing out might, it is true, in some cases cut a gorge so as to drain the basin, but this would not prevent a basin being formed. In the western Alps, where the height was greatest, there also were the largest and, in some instances, the deepest lakes; though the depth was connected to a great extent with the nature of the rock. Some lakes, however, had been partly filled by detritus. As to the cliffs, he perfectly agreed with Mr. Bonney in attributing them to meteoric causes; and in many cases he thought they were to some extent of preglacial origin, though subsequently much modified. He repudiated any idea of the larger valleys having even in glacial times been completely filled with ice, and deprecated judging of these questions from diagrams, in which the horizontal and vertical scales were different. He repeated that the original large valleys were in his mind of great antiquity, but all rather due to erosion in some form or other than to any internal disturbances of the strata. They were also to a great extent cut out before the last glacial period. He had been much gratified to find that, after so many years of opposition, the result of Prof. Gastaldi's mapping of the country on which he had founded his own opinions had been to bring the Professor round to the adoption of the same conclusions.

Mr. Blanford added that in the Neilgherries in India, and in Abyssinia, he had not been able to trace any ice-action whatever, and there also he had not seen any cirques; and, moreover, there were no lake-basins. He was therefore compelled to connect both lake-basins and cirques with the existence of glaciers.

Mr. Campbell of Islay, referring to that portion of the paper in which the author alluded to partial subsidence and flexure to account in some degree for the basins of the alpine lakes, described the Thingvalla lake in Iceland. That hollow is over six miles wide, and for a length of more than twenty miles clearly is the result of fracture and subsidence of the crust formed upon a great lava flood. Mr. Campbell pointed out that the alpine hollows were not like this Icelandic subsidence, and attributed them to erosion, not to subsidence and flexure. Subsequently the author said that he attributed the valleys to erosion.

The President thought that Mr. Bonney's paper as to the formation of these particular lakes had not been answered. It seemed to him that what had been said as to the filling by ice of the valleys with cirques at the sides did not in any way imply that the valleys had been formed by the action of ice. In the case of the Königsee the vast precipice at the end seemed especially an instance of a cliff that might have existed in preglacial times. He thought that the author's contention that such precipices could not have been formed by the action of glaciers was substantiated. At the same time he would not maintain that glaciers could not excavate basins, but denied their power to excavate deep basins with highly inclined sides. He wished that more attention had been paid to the stratigraphical features of the rocks in which the lakes were excavated. He cited Mr. Kinahan as having stated that the greatest depths of Loch Lomond coincided in position with faults which could be observed in the surrounding country. He differed from Prof. Ramsay as to the preponderance of lakes in regions which have been glaciated, and thought they were more closely connected with the configuration of hilly countries, which was by no means of necessity connected with glacial erosion.

Prof. Ramsay doubted the completeness of Mr. Kinahan's observations. As to cliffs surrounding lakes, he by no means thought that they were now in the same condition as when the glaciers retired. Such cliffs were in fact escarpments working back and undergoing constant change. He could not understand any one acquainted with regions that had been glaciated, as, for instance, Labrador, not connecting the prodigious number of lakes that prevailed with the action of the ice which once covered the country. The longer axis of the lakes in nearly all instances coincided with the general direction of the flow of the ice; and by itself alone this circumstance afforded great support to his views.

Mr. Bonney, in reply, pointed out that he had never denied that ice might once have occupied the bottom of cirques, and even have excavated some of the rock-basins. What he wished to maintain was the necessity of drawing a distinction between primary and secondary causes of the configuration of the country. He thought that the operation of secondary causes had been overrated, and wished that more attention should be paid to the circumstances of the particular lakes to which he had called attention.

VISIT OF THE GEOLOGISTS' ASSOCIATION TO BANBURY.—April 14th–17th, 1873.—Upon the recent visit to Banbury of the Geologists' Association, under the guidance of Prof. John Morris, F.G.S., of University College, London, and Mr. T. Beesley, F.C.S., much valuable instruction was gained by the party. Upon the forenoon of Monday, the 14th, the sections near the town, the Lower Middle Lias of Draper's Road, and the brickyard in Green Lane were inspected, and in the afternoon a more extended excursion was made. At Twyford Wharf brickyard (Lower Middle Lias), the *Ammonites margaritatus* beds, considered by Mr. Beesley (who will be remembered as the author of the "Geology of Banbury") to be here seen to the greatest advantage, attracted much attention, and a fair number of *Belemnites*, *Cypricardia*, and other fossils were secured; and Mr. Beesley pointed out the difference between the peculiar assemblage of fossils here met with, and those which occur in the Upper Marlstone. At Warkworth, on the other side of the valley, a large number of fossils were obtained, and Prof. Morris explained the interesting character of the quarry. The beds belonged to the Marlstone series, part of the Middle Lias. The quarry showed some of the characteristic Ammonites, species never found in the Upper or Lower Lias, and he observed that from the appearance of the fossils found, and their nature, they might conclude that they stood on what had been a shallow sea. There were three groups of mollusca here, and Mr. Beesley said they had found vertebrate remains and true coprolites, as well as Crustaceans. The King's Sutton Ironstone Quarry (Marlstone) was next visited, and a number of interesting fossils were found. Prof. Morris directed attention to the remarkable abundance of lamp shells in proportion to other shells; the section showed the *Ammonites spinatus* zone. The party next proceeded to the scene of the whirlwind in November last, and at Newbottle Hill the section showing junctions of Marlstone, Upper Lias, and Inferior Oolite was pointed out. Prof. Morris here gave a very interesting address upon the geology of the neighbourhood, and drew attention to the effect which geological changes had produced upon the present configuration of the surface. At the conversazione held (through the influence of Mr. Beesley) at the Town Hall in the evening, a really creditable geological museum was, with the able assistance of the Messrs. G. Stutterd and E. Walford, extemporized, Mr. H. Walford contributing some valuable Japanese bronzes, whilst Mrs. and the Misses Beesley took upon themselves the task of performing the charitable office of entertainers, by taking care that ample refreshments were provided. The excellent collection of fossils and geological specimens, chiefly local, afforded an excellent opportunity for again drawing on Prof. Morris's extensive knowledge; and in the course of the evening an address, which was really an exhaustive lecture, upon the formations represented by the specimens, was obtained from him, in which he pointed out the great advantage derivable from the study of physical science. They would see, he observed, how the features of the landscape were affected by the nature of the rock structure, and it was only geologists or those well acquainted with physical science that could fully appreciate this. They would find that the mineral structure of the rocks in the neighbourhood sometimes gave them pasture and sometimes arable land. This depended upon the ancient geological conditions. There was mostly pasture land on the Upper Lias, and on the intermediate or Marlstone there was both arable and pasture; the Marlstone was rich in shells and phosphates, and was more valuable as arable land than the Upper or Lower Lias. A hearty vote of thanks was given for the address. On Tuesday the 15th, the party visited the "fault" which runs from the Broughton Road across the low ground between Constitution and Crouch Hills, parallel with another fault starting at Hardwicke, and which brings down the Upper Lias between the Marlstone. At the Giant's Cave Mr. Beesley pointed out the second fault just mentioned. At Broughton the castle and the church were visited, and at the Broughton Fulling Mill Quarry the Lower Beds of the Great Oolite tilted at a considerable angle to the south were examined, and as Tadmarton Forest marble pits were approached many fossils belonging to the Cornbrash beds were found, confirming the view taken by the Geological Survey officers, that the slaty beds at the top of this quarry are true Forest marbles, which has been doubted by some geologists. After luncheon Prof. Morris and Mr. J. Logan Lobley (Hon. Secretary) formally thanked Mr. Beesley on behalf of the Geologists' Association for the cordial reception they had met with, and expressed their indebtedness to the town and people of Banbury for the kindness shown them. On Wednesday the 16th, visits were made to Fenny Compton, Kineton, and Edgehill, and on Thursday, the 17th, to the Upper Lias of Northamptonshire side, some good fossils being got at the brickyard at Thenford Hill. The Association have probably never had a more enjoyable excursion, nor one from which more sound instruction has been gained.

GEOLOGISTS' ASSOCIATION — May 2, 1873. — Henry Woodward, Esq., F.G.S., F.Z.S., President, in the Chair.—"On the Valley of the Vézère (Périgord), its Limestones, Caves, and Pre-historic Remains," by Professor T. Rupert Jones, F.R.S., F.G.S.

The river Vézère, rising in the Department of Corrège, traversing the Department Dordogne, and joining the river Dordogne near Sarlat, runs from the old metamorphic

of the central plateau of France, through Carboniferous, Triassic, Jurassic and ›eous strata. The last mentioned are chiefly limestones, nearly horizontal, pre- g steep and often high cliffs, either washed by the river, or bordering its broader der valley. The softer bands of limestone have been hollowed out along the by frost and water, and here and there present recesses and caves. These, eral instances, have been artificially enlarged, and in very many cases have ed shelter to pre-historic people, and still retain heaps of bones and hearth-stuff, flint implements of numerous kinds, carved bones, antlers, and occasionally 1 bones. The most common bones and antlers are those of the Reindeer, which have abounded in Southern France, whether remaining all the year round, or ting from plain to mountain and back again in their season, for the cave-folk them of all ages in vast numbers. The cold climate necessary for the Reindeer ng passed away; the Musk Ox and the Hairy Mammoth disappeared also with indeer; and, looking at the great changes in geographical outlines and contours 1ave taken place since the extinction of the European Mammoth, the author ht that some eight or nine thousand years would not be too long for the bring- bout of such changes. That the old Cave-folk of Périgord saw the living noth, a lively outline-sketch of its peculiar and shaggy form on a piece of ivory, in the Madelaine Cave, is satisfactory evidence. The special geology of the ›t, the characters of the several caves and their contents, and the most striking e implements of stone and bone, were described in this paper; the human 1s found at Cro-Magnon, a gigantic chief and his more ordinary companions, specially treated of; and the high probability of their belonging to the same f men as the older Cave-folk was discussed at some length.

CORRESPONDENCE.

LOWER *SCROBICULARIA* AND LOWER *CYCLAS* CLAYS OF THE MERSEY AND RIBBLE.[1]

R,—On the 14th of Nov., 1871, Mr. T. M. Reade read a paper 1e Geological Society of Liverpool, "On the Geology and ›ics of the Post-Glacial Period," of which an abstract was given *iture* of December 28 (vol. v., p. 175), and a réchauffé by Mr. e in the GEOL. MAG. for March, 1872 (Vol. IX., p. 111), in which h my "Explanation of Map 90 N.E." was published, which ins a description of *Lower* SCROBICULARIA *Clay* at Crossens, in ashire; from which it will be seen that it is impossible for me ve first learned of such a clay in that county from Mr. Reade's rs, as he suggests, as no reference is made to it in the Abstract in *re*, and my "Explanation" was then in the press, which latter written from notes made previously to my leaving South-west ashire, in December, 1868. And in point of fact, I never saw aper until the present year, he not having favoured me with a nt, in return for those of my own (sent at his request), and for es to his letters asking for information.

·. Reade charges me with inaccuracy, because certain thin clays, *Scrobiculariæ*, one to twenty feet in thickness, never cropping to urface, and overlaid by from ten to seventy feet of still newer sits, which he has discovered in his draining operations, *near* oast (carried out since I left the district), are not shown on the . I reply that, even were the '*Lower Scrobicularia* Clay' a e-soil, it could not be separated from the '*Lower Cyclas* Clay,' with which it is intercalated, and which it apparently sometimes entirely replaces, the two deposits being *lithologically one*, any division between them would be a *zoological* boundary.

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[1] This correspondence must now terminate.—ED. GEOL. MAG.

I am not surprised to hear of Mr. Reade's discovery of marine shells in a hole in the lower part of the grey clay, beneath the peat of Alt mouth, as I showed in my paper read at the Geol. Soc. of London, June, 1870, that beneath the peat and grey clay there is almost always a bed of Post-tertiary *marine* (Shirdley Hill) sand resting on denuded Boulder-Clay. But the upper part of the grey clay there I know to be of freshwater origin, containing rushes and other plants, as well as freshwater shells, which, however, are by no means common.

Freshwater shells also occur in the grey clay, beneath the peat, at the brick-pit, near the Isle of Wight, Birkdale, which I constantly visited during my nine months' stay at Birkdale, never finding any marine forms in it, though they occur abundantly in the silty-clay *above* the peat, and fragments of sea-shells were found in the Shirdley Hill Sand, underlying the grey clay of this pit.

The sand was absent in the Journal of the boring made at the Palace Hotel, Birkdale Park, communicated to me in 1868, by Mr. Holbrook Gaskell, J.P., the chairman of the Company, the peat and grey clay together having thinned to 18 inches, and being overlaid by 79 feet of modern sand, partly blown.

I would remind Mr. Reade that the peat *over*laps the grey clays, and rests on marine sand and Boulder-clay, and that these clays have therefore nothing like an area of 75 square miles, as he states. And that, again, this plain is only a portion of a larger one, since destroyed, in which the waters of the Mersey and Ribble met, not the brooks now draining into the 75 square miles.

H.M. GEOLOGICAL SURVEY,
AMBLESIDE.

CHARLES E. DE RANCE.

OBITUARY.

ON the 24th of April died Mary Elizabeth, the wife of Sir Charles Lyell, Bart., in the 65th year of her age. Lady Lyell was the eldest daughter of Leonard Horner, Esq., F.R.S., a prominent member of the Geological Society from its foundation down to his death in 1864. In 1832 she was married to Sir Charles, then Mr. Lyell, and ever since constantly accompanied him in his several geological visits to North America, as well as on almost all his journeys on the Continent of Europe as well as in England. Lady Lyell entered warmly into the scientific pursuits of her husband, and keenly appreciated the continual changes and advances in geological knowledge. By her energetic assistance in writing from dictation, the labour of bringing out the several editions of the works on Geology, by Sir Charles Lyell, was materially lessened; and scarcely a proof-sheet was finally sent off to the printer without being first submitted to her for criticism and approval. In this way one of the last acts of her life was to read over the concluding chapter of the fourth edition of the "Antiquity of Man," just published.

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ORIGINAL ARTICLES.

I.—ON THE OCCURRENCE OF A QUARTZITE BOULDER IN A COAL-SEAM IN SOUTH STAFFORDSHIRE.[1]

By Rev. T. G. BONNEY, M.A., F.G.S.,
Fellow and Tutor of St. John's College, Cambridge.

INTERRUPTIONS in the continuity of a Coal-seam, whether in the form of intercalated layers of sand or shoals of clay, are not rare; but I have been able to find little on record concerning the occurrence of pebbles of any considerable size, except where there was reason to suppose that the miners had struck upon an old river channel. The Boulder, which forms the subject of this paper, was found in the 13th Coal of the sinkings belonging to the Cannock and Rugeley Colliery Company; and I am indebted to the kindness of its manager, E. C. Peake, Esq., for the opportunity of exhibiting the specimen and for much of the following information. The seam occurs at a depth of about 540 feet from the surface of the ground; the Boulder was completely enveloped in the coal, but its precise distance from the top of the seam was not ascertained. This 13th coal is considered to be identical with the 12th coal in the Brereton Colliery. In the latter colliery this seam is about 135 feet above the lowest or 15th coal; and by boring to a depth of 68 feet, red rocks were reached, which very probably, like those detected in the sinkings at Halesowen, belong to the passage-beds between the Silurian and Old Red Sandstone.

The Boulder is in shape subspheroidal; having been probably once a rhombic parallelopiped, defined by joint planes whose angles have since been worn away. Its girth in two directions at right angles is about 19 inches, and its greatest thickness about 4 inches; it weighs 13 lbs. 13½ oz. The rock is a very compact and highly altered pale grey quartzite, with a sharp almost conchoidal fracture; lines on the exterior roughly parallel to its flatter ends probably indicate divisional planes due to original stratification. Lithologically it resembles very closely one of the varieties of quartzite which is very common in the Bunter pebble-beds of the neighbourhood.

Two questions at once present themselves with regard to this Boulder—(1) How did it come, (2) whence did it come, into the position in which it was found?

(1). The absence of other pebbles shows that a stream alone, even in flood-time, is not likely to have brought it. For a torrent strong enough to have transported such a Boulder could have hardly failed to throw down grit enough to spoil the neighbouring coal. At the same time it must have been brought by a swollen stream, for otherwise whatever acted as a float could hardly have penetrated the dense mass of vegetation constituting the coal-seam. The only agents that appear likely to have transported it are ice or a tree. The former does not appear a probable one at this period of the world's history; the Boulder, however, could readily have been brought entangled in the roots of a tree, which might have been torn up during some unusually high flood, have been swept by an eddy out of the course of the main current, and have been left in the jungle on the retreat of the water. In process of time the tree would be imbedded in a coal-seam, and any trace of it would easily be overlooked by the workmen. The finer sediment would be washed out on the journey.

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[1] Read before the Cambridge Philosophical Society, March 3, 1873.

(2). The locality whence this Boulder came is a harder question to determine. There are quartzites at the Wrekin and the Stiper stones, but not, I believe, exactly of this kind. The two localities known to me where a similar rock occurs within a moderate distance are Hartshill, near Nuneaton (to the S.E.), and the eastern side of Bromsgrove Lickey (to the S.). The former of these is supposed to be an altered Millstone-grit; the latter is of Upper Llandovery age. Both resemble the rock of the Boulder and of the Bunter conglomerate; the former most closely. But not only is it in the highest degree probable that both these quartzites were buried beneath many fathoms of strata in the Triassic age,[1] but also, if we regard the distribution of the Bunter pebbles, it is almost impossible that they can have furnished the materials. Again, the South Staffordshire Coalfield is on the northern slopes of the great barrier which in the earlier Carboniferous periods separated the northern and southern sea-basins, and this, if ever quite overspread by Coal-measures, would not be till rather late in the period. Thus we are driven to seek a northern rather than a southern origin for the Boulder. The sedimentary materials, as Mr. Hull has shown in a very able paper,[2] during the Triassic as well as the Carboniferous period came from the N.W., passing through the open space between Cumberland and Wales, then probably the embouchure of a great river. The Bunter *pebbles*, however, seem rather to have come from the N.E., brought by the current of another stream (which may have drained a considerable area to the eastward of the Firth of Forth), or possibly rolled along the coast-line of the Pennine chain, as in later days the pebbles washed out of the Boulder-clay have travelled down the eastern shores of England. He suggests that they have been originally derived from the quartzites of the Northern Highlands, and have halted on the way in conglomerates of intermediate age. With this opinion, after examining several conglomerates of Old Red Sandstone and Carboniferous age in Scotland, I fully concur. The Bunter conglomerates of the Midland Counties, with which I am very familiar, only differ from some of those in Scotland in the greater prevalence of quartzite pebbles; this, however, is merely a case of the 'survival of the fittest,' for a quartzite is one of the most durable of rocks.

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[1] If the Hartshill rock be Millstone-grit, it would probably be unaltered at this rather early epoch of the Coal-measures.

[2] Quart. Journ. Geol. Soc. xviii. p. 127; and Triassic and Permian Rocks of the Midland Counties (Memoir of the Geol. Survey), p. 60.

We are, I think, justified in looking to a distant locality for this Boulder; because, had it come from near, pebbles of considerable size would be common in the Coal-measure sandstones, which is not the case in Central England; indeed, I am not aware of any instance either in the Carboniferous or Permian periods (for the breccia of the latter is no parallel) where quartzite Boulders of this size have been observed. I should therefore suppose that it had been brought during a flood from some deposits to the N.W., similar to those which still remain in more than one place about the Firth of Clyde. It might, indeed, have come, like the Bunter pebbles, from some Old Red Sandstone district to the east of the present Lammermuirs; but, as the Pennine chain did not then exist, and as the streams, judging from Mr. Hull's curves of thickness,[1] ran in a south-easterly direction, it is difficult to understand how anything could have drifted across the line of their current to the position of this Boulder. Both explanations have their difficulties; indeed, with our present knowledge, we can do little more than state the problem, and leave its solution, like that of many other kindred investigations, to the future.

II.—On "Blocky" Rock Surfaces, and the Theory of the Shrinking Nucleus of the Globe.

By G. Poulett Scrope, F.R.S., F.G.S., etc.

The article by Mr. Clifton Ward upon "Rock Fissures" in the Geological Magazine for June, has reminded me of a special characteristic of some igneous rocks, which has been perhaps as yet imperfectly appreciated. I mean by igneous rocks, such masses of subterranean mineral matter as have apparently thrust themselves upwards to the surface of the globe by a process of internal expansion or intumescence, caused by heat—not always attaining absolute fusion, but in some degree owing to the general permeation of the matter by super-heated water, or steam, or other gases.

The characteristic I refer to is the superficial fissuring of these rocks in the manner aptly called by Mr. C. Ward "blocky"; the surface of the rock or mountain, as in one of the examples described by him, viz. the summit of Scafell Pikes, "being thickly strewn over with large rough blocks of stone, so that one's progression is often limited to jumping from rock to rock." No words could more exactly describe the conformation of the surface of many erupted volcanic masses, such as the basaltic hills of the Siebengebirge; the extremities of the basaltic plateaux that reach the valleys of the Borne

[1] Quart. Journ. Geol. Soc. xviii. plate vii.

and Loire, near Le Puy, in Central France; the great lava-field at the foot of the Peak of Teneriffe, within the vast encircling 'cirque' described by Prof. Piazzi Smyth as a chaos of tumbled blocks, more or less cuboidal, and varying in size from that of a house downwards. Such, too, seems to be the character of the surface of the great lava-bed of California, which was the last refuge of Captain Jack and his tribe.

Now what is the cause of this peculiar structure? Shrinkage during consolidation is the usual, and no doubt the correct, explanation. But how happens it that while some lavas on exposure to the open air are fissured and broken up into blocks in this extreme degree, others present a smooth and almost glossy exterior, wrinkled into cable-like folds, while others exhibit rude and jagged scoriform projections which have been compared to the waves of a storm-tossed sea frozen at the moment of its wildest disturbance? It is remarkable that lavas poured out from the same volcano at successive intervals sometimes present these distinct varieties of superficial structure, as for instance the several Vesuvian lava currents of 1871 and 1872, described by Prof. Palmieri (Account of the Eruption of March, 1872, Mallet's translation, p. 103), the former as breaking on exposure to the air into rude scoriform fragments (which he consequently calls 'fragmentary lava'); the latter coating itself with a uniform solid skin, more or less wrinkled, which he calls 'lava with united surface.' It is noteworthy that these two lavas differ also in mineral character —the former being rich in pyroxene, the latter in leucite.

In my work on Volcanos I have referred these differences in the forms assumed by lava surfaces on exposure to the atmosphere to corresponding differences in the grain or size of the crystals or granular particles that compose the lava at the moment of its outflow; the finest grained lavas approaching to the state of glassy fusion, being highly viscid and comporting themselves on exposure like melted glass or obsidian; the coarser-grained being yet sufficiently liquefied to admit of the formation of spherical bubbles of steam within them, and the upward movement and escape of these steam bubbles, under the influence of hydrostatic pressure; while in the very coarsest grained or extremely crystalline lavas, from want of sufficient mobility in their component particles, the steam only escapes by filtration through and between these particles, causing the sudden contraction and congealing of the mass and the formation of gaping fissures; this process rapidly reaching to a considerable depth, and the result being the separation of the surface into those more or less loose and cuboidal blocks, often of large size, which I have described above as characteristic of some lava-fields.

I do not, however, find that this explanation of the differences in question has met with much consideration or acceptance among geologists. The old notion still seems to prevail as to the equally complete fusion of all lavas at the time of their emission, and that their differences of texture are owing only to more or less rapid cooling, notwithstanding the certainty that the *surface*, at least, of every lava-stream exposed to the open air must be subject to prely the same rate of refrigeration, abstracting, of course, local and idental variations of atmospheric temperature.

would suggest, then, that whenever the surface of an igneous k, such as those described in Mr. Ward's paper, is seen to be med of tumbled blocks, and split by gaping fissures, it is pre- nably the upper portion of a protruded mass which reached its sent position in a state of igneo-aqueous liquefaction, and rapidly ting with its contained steam and heat on exposure to the nosphere, was rent and broken up by sudden shrinkage in the nner described above as characteristic of many fields of coarse- ined and highly crystalline lavas. As the process of consolidation l cooling extended downwards, the outwardly gaping fissures will re been continued in closer vertical joints; or, where the separa- n of the sides was considerable, these would be filled by the est grained material, or perhaps, liquefied silica, squeezed out m the contiguous crystalline mass, giving rise to the veins of er crystalline matters, or of pure quartz, with which these rocks so often penetrated.

Much that seems obscure in the position, structure, and texture the crystalline igneous rocks of all ages, as also in the influence y have exercised on the stratified rocks with which they came in ntact, would come out far clearer if it were borne in mind that these ks assumed their present positions while in the state of a more less pasty magma, highly elastic, *i.e.* having a tendency to expan- n, by reason of the quantity of super-heated water or steam dissemi- ted through its substance among the component imperfectly formed ystals or granules;—a view which I advanced nearly fifty years ck, and which has since been accepted by many eminent geologists.

For example, the more or less horizontal pressure that has evi- ntly been exerted in frequent instances by plutonic masses upon e strata through which they have burst up, shouldering aside and umpling them into anticlinal and synclinal curves, or causing mplicated faults in them when too rigid to bend—which forms the bject treated of by the Rev. O. Fisher in the elaborate article which llows that of Mr. Clifton Ward—is thus readily explained; since y elastic mass placed between the two opposite forces of the up- rust from below, and its own weight from above, must tend expand horizontally with enormous power. There would seem, en, to be no need to resort, for an explanation of these phenomena, the hypothesis of a shrinking nucleus to the globe. The rise om beneath the fractured crust of masses of granite or other utonic crystalline matter in a state of igneo-aqueous plasticity, and cessarily exerting an enormous horizontal, or rather diagonal, essure against the sides of the fissure through which the matter is sing, or in any direction that offers the least resistance,—together ith the tendency of the upraised strata, under the influence of avitation, to slip away from the axis or centre of elevation,—will, I ink, account for all the evidences of lateral thrust observable in e faults and crumpling of the strata.[1]

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[1] See Volcanos, p. 287, ed. 1872.

That heat is, and has always been, passing continually from the interior of the globe into space through the superficial rocks, by conduction, as well as by the agency of volcanic eruptions and exhalations, the upthrust of heated rocky matter, hot springs, etc., is an unquestionable fact. That this escape of heat occasions secular cooling and contraction in the entire globe, is but an hypothesis. It is quite conceivable that the heat so parted with may be restored in some manner, either from within or from without, as, for instance, is the case with the heat of a living animal.[1] All the phenomena of Volcanic and Plutonic action are explicable, as I have repeatedly shown, by the local changes of temperature and lateral shifting of heat that must be occasioned in the matter underlying the outer crust by local variations in the thickness and conducting power of the superficial deposits,—producing corresponding variations in the subterranean isothermal planes—which we know to be continually taking place. This, indeed, is admitted by Mr. Fisher, who quotes Mr. Babbage in support of the view that "the deposition of a stratum at the bottom of the ocean would raise the temperature of the rocks underlying the original surface by 2° Fahr. for every 200 feet laid down upon it."

I may mention here that so early as 1825, and consequently some years before the publication of Mr. Babbage's paper in 1834, I had suggested that the very different conductibility of the rocks forming the crust of the globe—and especially the resistance offered to the escape of subterranean heat by the deposition of "sedimentary limestones, clays, and sandstones"—must occasion corresponding changes in the temperature of the heated matter beneath, "the internal heat continually endeavouring to put itself *in equilibrio*."[2] It will be noted that this view is distinct from that of Sir John Herschel (published in the same year as that of Babbage), which attributed Plutonic and Volcanic movements to variations in the thickness and consequent *pressure* of the superficial deposits upon a liquid matter beneath, rather than to changes in the amount of internal heat due to variations in the conductibility of the outer covering. Perhaps, indeed, both causes may have co-operated. The increase of local pressure from above may, as already observed, have a mechanical effect in producing lateral movement in the more or less elastic matter beneath. But if the increase of heat, as may well be supposed, took place there faster than it could pass off laterally, either by conduction or actual change of place in the highly viscid, if not solid, matter, the results we should anticipate would be local expansion, metamorphism, disturbance, and upthrust, causing superficial elevation; in short, the exact phenomena of which such patent evidences are seen in mountain ranges.

Without, therefore, denying the possibility of the secular cooling and contraction of the nucleus of the globe, I maintain that the phenomena which it is brought forward to account for can be explained by deductions from ascertained facts without resorting to that hypothesis.

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[1] See Lyell's Principles, ed. 1872, p. 233.

[2] Volcanos, ed. 1825, p. 30

It may be said that the volcanic or trap rocks appear to have ffected very little disturbance in the rocks through which they have isen; violent disturbance and horizontal compression, as well as levation and metamorphism, being confined almost wholly to the xtrusion of the massive and highly crystalline rocks which are sually distinguished as 'Plutonic,' viz. the granites, porphyries, rpentines, etc., etc. This is, however, exactly what might be xpected on the supposition that the upthrust of the latter is the irect effect of their subterranean expansion from increase of heat; e rise of the former, the secondary effect of these movements, due the opening of lateral fissures, often at a considerable distance om the axis or centre of elevation, affording issue to portions of he heated interior suddenly relieved from pressure.

Such lateral fissures being almost necessarily parallel to the axes f elevation, we may see here the cause of the general parallelism f lines of volcanic eruption to the neighbouring continental ountain ranges, as well as of their frequent coincidence with coastines, that is, with the edges of the up-raised areas.[1]

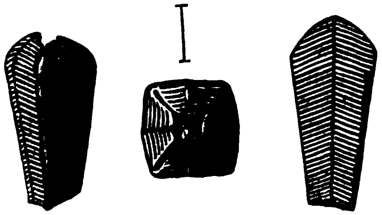
This view of the subject, I believe, corresponds more nearly with hat advocated by Captain Hutton, in his New Zealand lecture, than ith that of Mr. Fisher, who looks for his original cause of change n the assumed contraction of the earth's nucleus within a more or ess rigid crust.

III.—CONTRIBUTIONS TO CARBONIFEROUS PALÆONTOLOGY.

By R. ETHERIDGE, Junior, F.G.S., of the Geological Survey of Scotland.

I.—Note on the genus *Conularia*, Miller.

THE genus *Conularia* was first described by Miller about the year 1820, and afterwards more fully by Sowerby, as a "conical ollow univalve shell," (Min. Con., vol. iii. p. 107). It had preiously been figured by Ure under the name of a "curious fossil" History of Rutherglen and E. Kilbride, p. 330). Sowerby, amongst ther characters, noticed that in one of his specimens, formerly in Miller's collection, the edges or "lips" of the broader or truncated nd of the shell were inflected, and nearly met in the centre (l. c. t. 260, fig. 4).



Conularia quadrisulcata, Sby. Upper Limestone (Carboniferous) series. Williamwood near Glasgow.

The specimen in question appears to have been in a very mutiated and crushed condition, and if we are to judge from Sowerby's figure this character might be easily overlooked, as it seems to have been by most subsequent writers, indeed it might well be mistaken for merely the sides of the shell crushed in. The very fragmentary form in which we usually find *Conularia* goes far to prove the thinness and delicacy of its test, and it may be on this account that the structure of the larger end is so seldom preserved.

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[1] See Volcanos, pp. 275–287, ed. 1872.

A small, but well-marked specimen of *C. quadrisulcata*, Sow., from the shale of the Orchard Cement Stone (Up. Limestone series) at Williamwood, four miles south of Glasgow, in the possession of Mr. J. Bennie, of the Geological Survey of Scotland, enables me to confirm Sowerby's description of the inflected margins of the mouth in *Conularia*. At the point at which we usually find the conical sides of the shell broken off, all four margins are uniformly inflected and bent down, but do not meet in the centre of the truncated end; on the contrary, a quadrangular opening is left, with the four corners forming re-entering grooves, which join the four angles formed by the union of the conical sides of the shell. On the face of each inflected margin is a sharp ridge, corresponding to that running down each side of the cone, crossed at an angle by similar transverse granulated striæ. It is probable that these inflected surfaces were continued still further inwards and upwards, as one or two of the central ridges show some traces of fracture. Whether this structure closed the orifice of *Conularia* or not it is difficult to say. It may have acted the part of the Operculum in an allied form, *Theca operculata*, Salter (Mem. Geol. Survey, vol. iii., app. p. 351, t. 10, f. 22–24), from the Lower Tremadoc beds, at Portmadoc, although itself not an Operculum in the true sense of the word.

The affinities of *Conularia* have been the source of much difference of opinion amongst Palæontologists. Its original describer, Miller, placed it with the Cephalopoda; in this he is followed by Fleming (Brit. Animals, p. 240) and others. On the other hand Sowerby considered that it had affinities with *Teredo* (Sow. l. c. p. 107). D'Archiac and De Verneuil were, so far as I am aware, the first to place *Conularia* amongst the Pteropoda (Geol. Trans., second series, vol. vi., pt. 2, p. 325), and there, for the want of better defined affinities, it has remained. Prof. Hall placed the genus amongst the Cephalopoda from the fact that a Trenton Limestone species, which he referred to *Conularia* (*C. Trentonensis*), had perforated septa, as in *Orthoceras* (Pal. New York, vol. i. p. 222); but the probability is that the form in question is not a *Conularia* at all, although Sowerby in a measure somewhat confirms this view when he speaks of the presence of "imperforate septa" (Sow., l. c., p. 107). One of the chief arguments brought against the pteropodous nature of *Conularia* is that of its size, and again its alleged gregarious habit. We have only to turn by way of analogy to various other divisions of the animal kingdom to at once perceive the fallacy of the former argument. As regards its gregarious habit, I think solitary specimens are as common, if not more so, than their occurrence in associated masses. Like living Pteropods, *Conularia* appears to have had a fragile shell, though, perhaps, in not so marked a degree as is to be found amongst existing forms. The shape of the shell somewhat resembles that of certain living genera, as *Creseis,* Rang., and *Cuvieria,* Rang. For further information respecting *Conularia* I would refer those who take an interest in the subject to an article by Dr. G. Sandberger in Leonhard and Bronn's Jahrbuch, 1847.

IV.—ON SOME UNDESCRIBED SPECIES OF *LAMELLIBRANCHIATA* FROM THE CARBONIFEROUS SERIES OF SCOTLAND.

BY R. ETHERIDGE, JUN., F.G.S.

THE *Lamellibranchiata* of the Scotch Carboniferous beds appear to agree on the whole tolerably well with those of the series as developed further south, notwithstanding we here and there meet with well-marked varieties, and occasionally new species. These are not so numerous as might have been expected when we take into consideration the very different physical conditions which must have existed during the deposition of the series in the two areas.

In the present communication three forms will be noticed which appear to be specifically distinct from any yet recorded from British Carboniferous rocks. The first of these is an exceedingly well-marked species of *Conocardium,* Bron. (*Pleurorhynchus,* Phil.), for which I propose the name of *Conocardium decussatum,* from the characteristic ornamentation of the shell. It is a small species, of a regular horse-hoof form, with an exceedingly strong ridge separating the anterior and posterior sides, amounting almost to a keel. In general form it resembles *C. trigonale,* Phil., and some depressed varieties of *C. Hibernicum,* Sow., but may be at once distinguished from both these by the shell-ornamentation. The full description is as follows:

1.—*Conocardium decussatum,* sp. nov.—Shell obliquely horse-hoof shaped, very convex; anterior end produced, somewhat cylindrical, gaping, tapering towards the hinge-line; posterior end truncated, slightly flattened, produced abruptly into an elongated siphonal tube arising from the hinge-line, bounded by a very strong ridge or keel, passing from the beaks to the antero-ventral extremity; beaks nearly central, prominent, contiguous; hinge-line as long as the shell, terminating posteriorly in the siphonal tube; surface characteristically ornamented; the posterior end has from seven to eight concentric ribs, which bifurcate about half-way between the beaks and the shell-margin, and are crenulated along their whole course; posterior end minutely and regularly decussated, the interspaces assuming the form of elongated rhombs; the crossings of the radiating and horizontal striæ give rise to small nodes; margin crenulated.

The truncated end of *Conocardium* is usually considered as *anterior,* but I have followed the example of Woodward (Manual of Mollusca, 2nd ed., p. 455) and Baily (Journ. Roy. Geol. Soc., Ireland, vol. iii. pt. i. (n.s.) p. 24), by making the truncated end *posterior.* The siphonal tube, although broken off, shows a decided tendency to curve upwards.

Locality.—Found by Mr. J. Bennie in the shales of the Orchard Cement Stone (Upper Limestone series), at William-wood, about three miles south of Glasgow.

2.—For an opportunity of noticing the following species of *Pteronites*, McCoy, I am indebted to Mr. J. Young, of Glasgow, who first called my attention to it. It approaches in many of its characters *P. persulcatus*, McCoy, but is smaller and differs considerably in the ribbing of the shell. I propose for it the specific name *P. regularis.* In *P. persulcatus* the ribs are coarse, rugged, flexuous, irregular. slightly interrupted ridges, larger and smaller. The ribs in the new species show no alternation in size, are equal, sharp, regular, and much finer and more numerous in proportion to the size of the shell; neither do they show any tendency to become rugged and broken up, as in McCoy's species, but pass direct from one end of the shell to the other. In *P. persulcatus* the ribs on the posterior wing are larger, and separated by broader interspaces than those on the body of the shell, but in our new form, *P. regularis*, there is no apparent difference, all the ribs possessing the same flexuous even aspect. Its characters are as follows:

Pteronites regularis, sp. nov.—Shell transversely-trigonal, depressed; anterior end small, pointed; posterior end thin, delicate, apparently subtruncate; hinge-line well defined, about equal to the width of the shell; beaks sharp, nearly terminal, slightly prominent; ventral margin without any visible sinus; shell thin; surface with numerous regular, sharp, flexuous, equal, persistent ribs, which pass in a close unbroken manner from one side of the shell to the other.

Localities.—Arden Quarry, near Thornliebank, Renfrewshire; Linn Spout Quarry, Dalry, Ayrshire; at both localities in shale under the Thornliebank and Arden Limestones (Upper Limestone series) associated with *Estheria punctatella*, Jones.

3.—The generic affinities of the next species do not appear to be as clear and decided as those above described, and the creation of a new genus for its reception, on the strength of the only single specimen with which I am acquainted, would be rather hazardous, especially as some of the characters are not sufficiently well marked. I have provisionally referred it to Schlotheim's *Myacites*. The absence of an erect dorsal margin at once excludes it from *Sanguinolites*, McCoy, and *Edmondia*, de Koninck. In neither of these shells is the tapering of the posterior side so marked as in the present species; even in the presence of an erect dorsal margin it would not be prudent to refer it to the latter genus without some indication of the hinge mechanism. In form, the shell at present under consideration approaches nearest to *Myacites*, possessing the exact outline of many Secondary species of that genus. The presence of *Myacites* in palæozoic rocks is a debated point, but as it is sanctioned by Prof. Morris in his '*Catalogue*,' it must be retained until a better genus is proposed for the shells at present included in it. Prof. King considered *Myacites* equivalent to his *Allorisma* (Perm. Foss., p. 196), and proposed the substitution of the one term for the other, the only reason assigned for this change being that the name *Myacites* implies that the shells are fossil *Myas* (l.c. p. 196, note). However this may be, it is evident that a genus is required for the reception of numerous Carboniferous shells which neither fall into *Sanguinolites* on the one hand, or *Edmondia* on the other. Such are those usually referred to *Myacites*, and so far as the character of the present species can be made out, it appears to be one of them. If *Myacites* and *Allorisma* are synonymous, it can only be in the case of the latter genus, as afterwards restricted by Prof. King (l.c., p. 196), because, as at first constituted (Annals and Mag. Nat. Hist., 1845, vol. xiv. p. 316), *Allorisma* combined two shells of totally different characters (Perm. Foss., p. 162). I propose the name *M. tenuilineata* for this form, which was kindly lent me for description by Mr. D. J. Brown, of Edinburgh (by whom it was found). Although not in the best state of preservation, its specific characters appear to be these:

Myacites? (*Allorisma*) *tenuilineata*, sp. nov.—Transversely elongate, produced posteriorly, inequilateral; anterior side short, rounded; posterior side narrowed, acuminated, somewhat produced; ventral margin convex; dorsal margin gradually descending to a blunt termination; beaks large, depressed, apparently somewhat incurved; shell convex, most so a short distance below the beaks, whence the sides slope rapidly to the ventral margin; surface with numerous close, thin, concentric lines, which here and there show traces of granulation.

Locality.—Lower Limestone series of Midlothian, at Cousland, near Edinburgh. The surface of the shell is much worn, but with a good lens traces of the granulation can be detected. This would still further tend to ally it with *Myacites*.

V.—ON A NEW METHOD OF WRITING CRYSTALLOGRAPHIC FORMULÆ.[1]

By FRANK RUTLEY, F.G.S., Geological Survey of England and Wales.

CRYSTALLOGRAPHIC, like all other formulæ, are simply short-hand methods of describing that which could otherwise only be rendered intelligible by the expenditure of many words, and, in type, by considerable waste of space. Anything, therefore, which tends to simplify and contract formulæ, without diminishing the amount of information which they convey, must necessarily be advantageous. The different systems of notation used at the present time by eminent crystallographers render the comprehension of their formulæ somewhat difficult to the student; and it would doubtless be productive of much satisfaction if a universal system of crystallographic notation could be adopted.

The method which I am about to describe will, I think, be found to fulfil all ordinary requirements, and might, if adopted, save time and space, and likewise diminish some of the difficulty experienced by the student. The symbols which I propose to use present, so far as I can see, no obstacle to the accurate rendering of any formula, and convey as much information as the more lengthy ones which are now in use. I would, however, wish those better qualified than myself to form their judgment upon these points, and merely submit this system to them in the hope that its simplicity may commend it, and that, by trial, they may remedy any defects by devising some more simple and better method.

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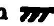
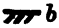
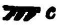
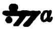
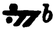
[1] The system of notation adopted by Prof. Dana is certainly as brief as the one now proposed, but does not appear to me to be so explicit.

In writing the formula for any face of a crystal, I propose first to draw a horizontal line or bar, which may be termed the *common* or *holohedral bar*, thus ; while to indicate hemihedral forms one end of the bar may be curved, thus . Any axis cut at a normal distance may be represented by a short vertical line joined beneath to the common bar, thus . For example, in the regular octahedron all three axes are cut at normal distances, and the symbol would consequently be . In this case the old symbol O is more simple, but the advantages of this system will become more apparent as we proceed.

The next innovation which I propose is to use a dot in place of the old symbol for infinity. The formula for the cube would therefore be instead of the old symbol ∞ 0 ∞ used by Naumann, and the Rhombic Dodecahedron would in like manner be represented by . It will now be seen that by this method the beginner has the advantage of noting at a glance the *number* of cut and uncut axes. The conventional distances *m* and *n* are represented by a prolonged vertical cross line for the former , and by a curved line for the latter, thus . So that the Hexakis Octahedron *m* 0 *n* of Naumann would be represented by . If it be necessary to express the linear values of *m* and *n*, then the formula may be written , which would represent a Hexakis Octahedron, any face of which intersects one parameter of normal length, and would, if produced, cut a second of triple that length, and a third of one and a half times the length of the normal parameter. In open forms the basal plane may be conveniently represented by , which should be placed over the mark which represents the axis cut by that plane: thus the Tetragonal Prism would be , and the Right Rhombic Prism would also be represented by the same symbol. The Hexagonal prism would differ in having an additional infinity-dot affixed, thus , to show that there is a fourth axis which is unavailable for the individual face formularized. The Rhombohedron would be represented by , because each face concerns four parameters; while the Scalenohedron would be .

In the Rhombic system Macropinakoids would be instead of $\infty \bar{P} \infty$, and Brachypinakoids instead of $\infty \breve{P} \infty$ of Naumann and the "*i*"s employed by Dana.[1]

In the Monoclinic system a slanting line indicates the clinodiagonal, and the oblique rhombic pyramid and prism would therefore be and ; while the oblique rectangular pyramid would and , the disconnected slanting dash being used instead of a dot to show that the clino-pyramidal faces do not cut the clinodiagonal. The oblique Rectangular prism will be and , the former for the ortho- and the latter for the clino-pinakoid. In the Triclinic system all the axes are slanted, and the symbols would be written *a* for the upper right posterior and lower left anterior faces of the doubly-oblique rhombic pyramid,  *b* for the upper right anterior and lower left posterior faces,  *c* for the lower right posterior and upper left anterior, etc.; while for the corresponding prism we should have *a* *b* etc.

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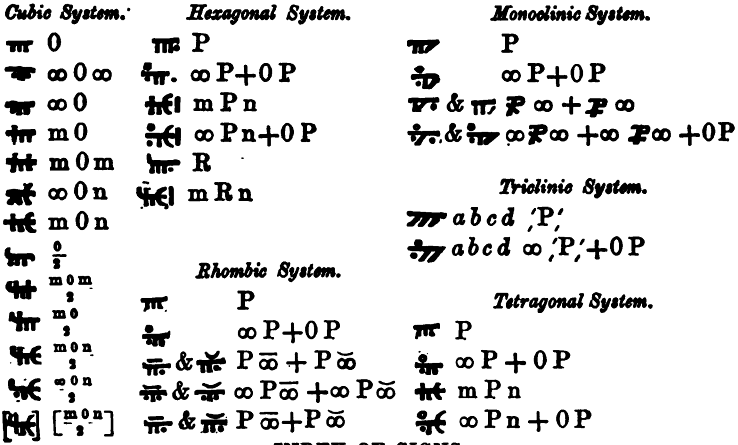
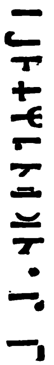
[1] The ordinary symbol in Naumann's notation, P, does not show the relation of each face of the hexagonal pyramid to the 3rd lateral axis.

The following lists, with the formulæ of Naumann placed opposite, will, I think, sufficiently explain all that requires explanation:


Cubic System.
0
∞0∞
∞0
m0
m0m
∞0n
m0n
0/2
m0m/2
m0/2
m0n/2
∞0n/2
[m0n/2]
Hexagonal System.
P
∞P+0P
mPn
∞Pn+0P
R
mRn
Rhombic System.
P
∞P+0P
&
P∞ + P∞
&
∞P∞ +∞P∞
&
P∞+P∞
Monoclinic System.
P
∞P+0P
&
P∞ + P∞
&
∞P∞ +∞ P∞ +0P
Triclinic System.
abcd ,P,'
abcd ∞,P,'+0P
Tetragonal System.
P
∞P + 0P
mPn
∞Pn + 0P

INDEX OF SIGNS.



Common bar.
" " (Hemihedral).
An axis cut normally.
" " " at m.
" " " " n.
" " passing uncut to infinity.
" inclined axis passing uncut to infinity.
Common bar of Macropinakoid and Macrodome.
" " Brachypinakoid and Brachydome.
A clino-diagonal cut.
A basal plane.
An axis lying at infinity to the particular face described and not cut by any plane dissimilar to that face.
An axis cut at an abnormal distance and not concerned in the formula.

VI.—On a Carboniferous Genus of Echinoderms with Overlapping Plates.

By John Young,
of the Hunterian Museum, College, Glasgow.

After reading the review of Prof. Wyville Thomson's "Depths of the Sea," in the May Number of the Geol. Mag., in which a figure and short description are given of a new living Echinoderm, which Prof. Thomson has named *Calveria hystrix*, one of whose peculiar features lies in its possessing overlapping plates, it may be interesting to readers of the MAGAZINE to know that besides the other species with overlapping plates noticed in the above-mentioned review, there were Echinoderms having their plates arranged on the same plan as long ago as the Lower Carboniferous Limestone period. Those to which I specially refer belong to the genus *Archæocidaris.*

The remains of one or two species of this genus are not uncommon in the limestone shales of the Scottish Coalfield, and in some localities, such as Craigenglen, near Campsie, the whole of the parts composing the organism may be collected in a fine state of preservation, although disconnected. Having, for a considerable number of years, paid attention to collecting the remains of *Archæocidaris*, I am now in a position to show, from numerous well-preserved ambulacral and inter-ambulacral plates, that their edges did not abut or join square end to end, like the plates of other normal species of *Echini* or *Cidaridæ*, but must have overlapped or imbricated each other to a certain extent—a feature easily recognizable upon the edges of many of the plates.

I had long ago observed the peculiar character of the bevelled edges of the plates in *Archæocidaris*, but could never understand their significance until I read the description and saw the arrangement of the plates in *Calveria hystrix.* I have now no doubt that those of *Archæocidaris* were arranged on a somewhat similar plan. It is not my intention to enter here upon a description of all the various parts of *Archæocidaris* that have been found, but I may briefly state that, besides the teeth of two very distinct species, I have found nearly all the portions of the lantern or dental apparatus, the various forms of plates composing the test, together with the large primary and smaller secondary spines. These we find in a condition in which all their articulating surfaces can be examined.

It appears that only the larger spines and plates of *Archæocidaris* were known to Prof. McCoy, who was the first to point out its generic characteristics, but he does not seem to have noticed the thin bevelled edges upon any of the inter-ambulacral plates which he describes. These, as he states, are of two kinds—a pentagonal and hexagonal series, which must have been arranged in the test in three or more rows. In this they differ from all Mesozoic and recent forms of *Cidaridæ*, which have only two rows. The large oblong pentagonal plates have two of the sides bevelled from above, the opposite side being bevelled on the lower edge. I have also observed in the same plates that one of the other two sides has a small groove in which the edge of the next plate was received. Probably this was an arrangement to retain the plates in proper position during elevation and depression of the test. The ambulacral plates are small, scale-like, and thinning from the middle towards their edges. They are of irregular form, and vary from $\frac{1}{8}$ to $\frac{1}{12}$ inch in breadth. In the centre of each plate there are a pair of small pores which are placed in the middle of a slight oval depression. Most of them are ornamented with one or two small tubercles, which probably bore minute spines. Along with the ambulacral are to be found numerous other small plates which cannot be distinguished from the former either in size or form. These, however, possess no pores; and whether they were arranged alternately with the poriferous plates, or formed part of the base or summit of the test, it is impossible to determine in their disjointed condition. Both sets show the overlapped portion of the plate very distinctly. The plates of *Archæocidaris* are thinner than similar plates in other species of *Cidaridæ* constructed upon the normal plan. This feature, taken along with the overlapping characteristics of the plates, may have given more flexibility to the test, like that observed in *Calveria*. If this were the case, and the plates held loosely together in the living animal, it may help to explain how very seldom it is that we find a specimen preserved with all its parts in position.

Sections of the larger spines of *Archæocidaris*, which I have recently prepared, show that they were tubular, the hollow interior, now filled with carbonate of lime, being a quarter of the diameter of the spine. In this other characteristic it also agrees with the *Diadematidæ* and the other species with overlapping plates noticed in the MAGAZINE.

VII.—ON THE OCCURRENCE OF LEAD, ZINC, AND IRON ORES IN SOME ROCKS OF CARBONIFEROUS AGE IN THE NORTH-WEST OF ENGLAND.

By CHARLES E. DE RANCE, F.G.S.;
of the Geological Survey of England.

(*Concluded from the February Number, p. 74.*)

PART II.

East Cumberland.—In the Cross Fell and Alston Moor district the Mountain Limestone is split up into numerous beds of limestone, sandstone, and shale, the thickness and character of which are well known through the local names given to each horizon by the miner, and from the writings of Messrs. Westgarth Forster, Sopwith, and Wallace.

The chief limestones in the Alston Moor district, down to the Great Whin Sill, a sheet of probably intrusive basalt, are the Little Limestone (20 feet below which are two Coal-seams, 18 and 12 inches thick respectively); the Tumblers or Great Limestone, about 70 feet thick; the Scar Limestone about 30 feet; and the Cockleshell Limestone about 18 inches, full of *Productus;* the Tyne-bottom Limestone, about 24 feet, resting on a shaly bed, which occasionally has a thin coal, which at Smitter Gill I found to be turned into an impure graphite, resting on the Great Whin Sill, which at Tynehead is 110 feet, but at Providence vein on the Tees considerably thinner. Of the Alston Moor beds, about 200 feet consist of limestone, 350 of sandstone, and 520 of shale; some of the latter beds are extremely well characterized, and maintain their thickness over a large area, like the Tyne-bottom plate, only 50 feet in thickness, overlying the Tyne-bottom Limestone. There are several limestones below the Great Whin Sill, extending through some 900 feet of measures, the chief of which is the Jew and the Melmerby Scar Limestone, 124 feet in thickness.

The very remarkable fault known as the "Great Sulphur Vein" traverses the country about W. and W.N.W. for a distance of nearly eight miles from Hard Rigg Edge, Melmerby Fell, (where it terminates against a S.W. fault) to the neighbourhood of Burnhope Seat, on the borders of Durham, where it spreads into a number of strings, which unite near Hiddenhole Mine. Following its course westwards it crosses a vein which has been worked in the Sir John's Mine. In the high level of this mine the miners, after penetrating the Sulphur Vein, which was no less than 180 feet in width, found the Sir John's vein on the opposite side, shifted 20 fathoms. This high level is driven on the north side of the Sulphur Vein, in the plate overlying the Scar Limestone, while on the south side it is in the plate under the Cockleshell Limestone, indicating a throw of more than 100 feet to the north. A little further west, the Sulphur Vein is well seen on the banks of the South Tyne, just below the Tynehead Smelt Mill, which is built on the Great Whin Sill, through which the river has cut a narrow gorge, terminating in a waterfall about 46 feet high, the base of the Whin Sill, abutting against the Sulphur Vein, which on the north side throws in the Tyne-bottom Limestone, which again forms the bed of the river.

The vein is found to be mainly made up of iron pyrites in a quartz matrix, with here and there large masses of the magnetic form—pyrrhotine, the latter was found to contain on assay small quantities of nickel and a trace of cobalt, and the former, assayed with the quartz matrix, about 40 per cent. of sulphur.

The low-level in Sir John's Mine is also driven through the Sulphur Vein, which there was found to consist of enormous masses of iron pyrites, with some copper. The latter mineral occurs in the Sir John's and in several other veins in Tynehead in the strata ranging from the top of the Scar Limestone to the top of the Tyne-bottom Limestone, but more particularly in the beds known as the Copper hazles, no less than 1600 tons of copper having been raised from the Sir John's Vein alone since 1811.

West of the Tyne the Sulphur Vein crosses the hill called Noonstones, where it consists entirely of pure white quartz; descending the hill, it is found in Cross Gill, where it was once, I believe, worked for a short time for gold; it consists of brown-stained quartz with ordinary and magnetic iron pyrites.

Still further west it was met with in the large mine at Smitter Gill, now abandoned, where many lumps of pyrrhotine may be seen lying on the refuse heaps, with fluor and other lode stuff derived from the lead lode.

Over the whole of these moors, and at the top of the 'Melmerby Scar Limestone,' occur many poor lead lodes, since abandoned, ranging a little north of E.N.E., nearly all of which, even in the thin limestones on the escarpment under the 'Melmerby Scar,' on becoming unproductive of lead, bear brown oxide of iron. The increased value during the last two years has caused these lodes to be actively sought for. The north and south cross veins appear to be the poorest, and do not bear iron, more than lead above the Great Limestone.

South of the Sulphur Vein the Sir John's and Clargill Head Old Veins have yielded a good deal of lead in the Hiddenhole Mine; and east of Slack's Rigg, the former vein was worked in the bottom of the Scar Limestone, which, though saturated with water and much iron-stained, contains no iron-ore, which in poor lodes takes the place of the Cornish Gossans, and in those portions of the lead and copper lodes that are almost wholly unproductive of these metals, fills the whole fissure of the lode of 6, 8, and even 10 feet in width, the limonite consisting of laminated stripes of different colours, the laminæ running in waving curves parallel to the sides of the lodes.

North of the Sulphur Vein, Sir John's Vein, worked at Stow Cragg, Lee House, and other Mines, has yielded considerable quantities of lead from the limestones, and copper from the sandstones, and in a portion of the lode the lead and copper are blended together. The back of the lode, both in the copper and lead portion, consists of hydrated per-oxide of iron, with veins of carbonate of lime. On the other side of the Sulphur Vein, the Sir John's and other veins parallel to it, especially High Tyne Green, Dosey, and Ladies Veins, are not very richly productive of lead or copper along a belt of country running through Bel Beaver to Tees, in a south-easterly direction, the whole lode being entirely made up of the hydrated per-oxide of iron, to the exclusion of all foreign material. The various levels driven into the hill-side, on the east side of the South Tyne and the col in which it takes its source, up to the river Tees, after passing through the lead belt, have cut into higher rocks productive only of iron. At the time these levels were driven iron-ore of this description was of little value, and heaps of it have been left around, the numbers of small shafts sunk in the course of the lodes, to extract the small portion of lead occurring here and there in the centre of the iron gangue.

The iron ore in these refuse heaps is generally light and honeycombed, with interstices in every direction; these I found, by analyses kindly communicated to me by Lieut.-Colonel A. M. Byng, to be due to the wasting away of the alumina and carbonate of lime, through the wash of rain and atmospheric action during the last 60 or 70 years. The amount of metallic iron in specimens I procured from the lodes at a considerable depth at the forebreast of the old lead levels both at Tyne Green and under the summit of Cross Fell, only averaging 33 per cent., while some of the ore from the heaps of *débris* averaged 44 per cent. of metallic iron, the iron ore being 8 feet in width, the walls containing a very large quantity of fluor: eastward on the Derwentwater estates of Greenwich Hospital, the iron is not present in this lode.

Traced eastward the iron in Sir John's and Tyne Green veins becomes rather siliceous, but parallel lodes in the adjacent manor of the Duke of Cleveland yield good brown per-oxide of iron, which is being accumulated in great heaps against the day when Middleton and Alston shall be joined by a railway.

A small W.N.W. anticlinal passes south of Bel Beaver, at John's Burn, west of Crookburn Bridge, on the Middleton road; the water travels through a subterranean channel. the limestone dipping 5° to N.W.; two small lead lodes cross the beck, in which no iron was observable. Below the junction of John's with Crookburn, the bar of limestone is seen, resting on sandstone; the former is overlaid, a little lower down, by 30 feet of Boulder-clay, at a height of 1770 feet above the sea. Reaching and ascending the Tees, the Tees Metal Band Mine is passed, where the surface of the limestone is covered with a curious enamel of brown oxide of iron and manganese. The lode stuff in the adjacent Providence Mine is very beautiful, consisting of crystals of galena, blende, and galena, with a breccia of broken banded chert pebbles set in quartz; no iron occurs here, but the lode was rich in lead, much of which probably still remains in the mine, the miners not having been able, with the existing machinery, to contend with the water—which drains in from the Tees.

A good exposure of the Whin Sill is seen in the South Tyne, around the Tyne Head Smelting Mill, at an elevation of from 1500 to 1560 feet on both sides of the river, which has cut a narrow gorge. On the west side of the South Tyne the basalt is capped by a cliff of stiff bluish-coloured Boulder-clay about 40 feet in height, containing a great number of scratched stones and boulders, but few of great size, and, as far as I saw, none of erratic origin.

Above the basaltic section, but below Calvert Fold, Black Shale and plates below the Scar Limestone is well seen, dipping N.E. at 12°, and then N.N.W. at 5°. Shale and plate are seen in the road near Tyne Green Mines (5° to N.W.), and at Ladies Vein the Four Fathom Limestone rests on a grit, from which a large specimen of *Sigillaria* was procured. On the slope of the Fell above, below Bel Beaver Rigg, occur thick Black Shales over the Scar Limestones, dipping S.E. at 5°, with numerous ironstone Septaria, with 38 per cent. of metallic iron.

The nodules of carbonate of iron occurring in the shales of these limestones, like the nodules of earthy iron ore in the Yoredale Shales of Lancashire, appear to have a similar origin to that adduced by Sir H. de la Beche, from the experiments of Mr. Hunt, F.R.S.,[1] to account for those in the Coal-measures, viz. that the decomposition of vegetable matter prevents the further oxidation of the proto-salts of iron, and converts the per-oxide into the proto-oxide "by taking a portion of its oxygen to form carbonic acid." The presence of *Sigillaria* in the shales of Ladies Vein, Tynehead, and the occasional fragments of ferns, prove that decomposition of vegetable matter must have gone on forming carbonic acid, which, mixing with the water, would spread over local areas, which "meeting with the proto-oxide of iron in solution," would unite with it and form a carbonate, mingling with the mud; and that impure beds either of carbonate of iron or lime would be thrown down, "according as the matter deposited from solution exceeded that thrown down from mechanical suspension," and both would form nodules when supplies of carbonates were short.

[1] Mem. Geol. Surv., vol. i. p. 186, London, 1846.

In some of the nodules, cracks radiating from the centre have been filled with galena and iron pyrites; those metals would appear to have been introduced in a soluble state after the formation of the cracks.

In the adjoining district of Weardale, in Durham, Spathic iron ores occur, in a similar manner, in lodes associated with lead and zinc ores traversing the Mountain Limestone; the higher part of these lodes are often found to be changed into brown hæmatite by the oxidation effected by air, and the percolation of water from above, which transmutation is found to descend for a considerable distance in the Spathic lodes of the Middle Devonian of North Devon and Somerset, described by Mr. Hilary Bauerman;[1] and similarly large crystals from Hüttenberg, in Carinthia, in the Museum of Practical Geology, exhibit the same change from "the elimination of carbonic acid, and the absorption of oxygen and water,"[2]—a like change having superficially converted crystals of iron pyrites "into brown iron ore, by the elimination of sulphur and the addition of oxygen and water."[3]

By a similar process, sulphide of lead and blende, exposed to the influence of waters charged with bicarbonate of lime, becomes superficially converted into carbonates, which is the case with lead left in several levels driven at the commencement of the present century in Tynehead, especially in the higher levels, water gradually losing its power of assisting the change from carbonate of iron to brown oxide, and of sulphide of lead and blende to carbonate, in proportion to the depth traversed, the oxygen probably having been taken up by the proto-oxides of iron in the shale, as suggested by Prof. Rogers, and Mr. Wallace, in his work on the Veins of Alston Moor.

In that work he describes the large quantities of carbonic acid often found in levels driven through shale in that country, and particularly the difficulty of contending with it at Long Clough Mine, Nenthead, where in making "a rise" to the surface, from the level, a seam of water charged with carbonic acid gas was met, which, when bored into from above, ran down the rise with a constant flow of water and gas. Mr. Wallace throws out the suggestion that the latter may be derived from the decomposition of overlying peat, but as it so often fills the cavern connected with the "flats" of the Great Limestone, and as I found it to occur suddenly in the main adit level of the Whitewell Mine in Yorkshire, through which there is perfect ventilation, it would appear to be more probable, that it is due to chemical change going on in the adjacent rocks, possibly the action of sour peat waters in limestone.

Many of the caverns in which occur the "flats" of this district appear to have been eaten out by the action of acidulated waters, acting along lines of joints unconnected with faults, rather than by a run of water, it being only certain beds, as the Great, Scar and Tyne-bottom Limestones that readily decompose, and form these flats of lead, which have much in common with the great sops of red hæmatite occurring in roughly N. W. and S. E. lines in the Carboniferous Limestone of Furness.

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[1] Metallurgy of Iron, third edition, 1872, p. 80.

[2] Hunt and Rudler, Descriptive Guide to the Museum of Practical Geology, Third edition, p. 84.

[3] *Op. cit.*, p. 94.

Mr. Wallace notices the fact that there are more joints in Alston Moor in the limestones than in the sandstones, and more in them than in the shales, and that the joints cease in depth; this I found to be the case over this area, but there are certainly as many joints in the Millstone *Grits* east of Chorley in Lancashire (where the master joint often runs parallel to a fault) as in the *limestones* of Tynehead. His observations as to their ceasing in depth I have noticed to be characteristic of joints in most formations. I had opportunities of corroborating his statement that joints filled with clay, often cross 'flats,' both empty, and filled with lead, and are certainly of later origin than the formation and infilling of the flats.

At Ashgill Mine both the veins and the flats contain oxide of iron, so that the introduction of the iron into the lodes of this district is probably of older date than the formation of the joints, the tops of which are covered near the Smelt Mill with Boulder-clay, but the clay found in the joints, like that in some lodes, appears to have been derived from the decomposition of limestone shales, or of beds like the pottery clay of Bel Beaver, associated with the thin coals, from which clay bottles and pipes were formerly made.

Ashgill Mine is remarkable for the lode being rich below the Great Limestone, though poor in that bed, which yielded in Alston Moor, according to Mr. Sopwith, F.R.S., 14,397 tons, while no other bed furnished more than 500 during three years; and which bed I believe to be the same as the 12-fathom of Yorkshire described in the early part of these notes.

The Little Limestone appears to be the highest rock in which zinc occurs in Alston Moor, descending to the base of the Great Limestone. In the Coal Sills and Little Limestone it is associated with oxide of iron, and at Guddamgill Burn this limestone is turned into a carbonate of iron, which is also the case with the Fell Top Limestone at Rampgill vein: much carbonate of iron is present in the basalt of Tyne-bottom Mines, which I found to oxidize on exposure to the air, which is again the case with strings of iron in the Whin Sill of the Tees, and the siliceous lodes in the Whin Sill of Tynehead.

Sulphate of Barytes occurs plentifully in the numerous small and poorly productive lodes intersecting, and often slightly faulting, the westward escarpments of Cross Fell: it is here associated with galena and fluor; the latter occurs plentifully in the east and west lodes, between Cross Fell and and the South Tyne, but I failed to find any in the Great Sulphur Vein.

Reviewing the evidence afforded by this district, it would appear that lodes running in all directions are at times productive of iron, in all limestones, from the lowest to the highest, but that the Tyne-bottom, Scar and Great Limestones are the most productive. Lead occurs in all the limestones, from the Melmerby Scar upwards, and in many sandstones, but it is quite possible that the poorness of the lower beds is due as much to their unfavourable position, as to the percolation of water from only cropping at the escarpment of Cross Fell. Zinc ranges from the Little Limestone down to the base of the Great Limestone. Copper from the top of the Scar to the top of the Tynebottom Limestones, especially in the copper hazles. Lastly, the greater the inward dip, the larger the supply of metal.

NOTICES OF MEMOIRS.

I.—CONTRIBUTIONS TO THE STUDY OF THE ERRANT ANNELIDES OF THE OLDER PALÆOZOIC ROCKS. By H. ALLEYNE NICHOLSON, M.D., D.Sc., M.A., Ph.D., F.R.S.E., Professor of Natural History in University College, Toronto. [Proceedings of the Royal Society, May 8th, 1873.]

IN this communication the author endeavours to elucidate the abundant and obscure organic remains which are found so commonly in the Palæozoic rocks, and especially in the Silurian strata of Britain, and which are generally known by the vague and convenient names of "Fucoids," "Annelide-burrows," and "tracks." After expressing his opinion that the first step towards the study of these obscure fossils lies in the provisional grouping and naming of the more marked forms which are already known to exist, the author proceeds to divide the remains under consideration into two great groups. In the first of these groups are those fossils which are truly the *burrows* of marine worms, as distinguished from mere trails and surface-tracks. Some of these burrows (*Scolithus*) are more or less nearly vertical in direction as regards the strata in which they are found; and they are to be looked upon as being true burrows of habitation. In this section are placed the genera *Scolithus*, *Arenicolites*, and *Histioderma*. Other burrows are of a totally different nature from the preceding, and may reasonably be compared to the burrows of the recent lobworms. These burrows run more or less horizontally as compared with the laminæ of deposition, or they penetrate the strata obliquely. They are not burrows of habitation, but are wandering tunnels excavated by the worm in its search after food. The fossils of this group, therefore, as preserved to us, are not the actual burrows themselves, but the burrows filled up with the sand or mud which the worm has passed through its alimentary canal. The burrows of this kind (including many forms previously described under the names of *Chondrites*, *Palæophycus*, etc.), the author groups together under the name of *Planolites*.

The second great group of Annelide-remains comprises genuine surface-trails or "tracks," which of necessity never pass below the surface of the bed on which they occur. Some of these remains, such as *Crossopodia*, are, beyond doubt, due to the operation of marine Annelides; but it may be a matter of question whether we have in these cases the actually petrified body of the worm, or merely the track produced by the passage of the animal over the surface of the mud or sand. The author, however, gives reasons for believing that the latter explanation is truly the correct one. Other fossils belonging to this group (such as *Myrianites*) are equally, beyond doubt, produced by the operations of marine animals: but it remains quite uncertain whether they have been formed by Annelides, Crustaceans, or Mollusks. Lastly, there are remains which appear to be really *casts* of the surface-trails of Annelides or other marine creatures, and which, therefore, are elevated above the surface of the bed on which they occur. Such remains may readily be confounded with those belonging to the genus *Planolites*, from which they are only distinguishable by the fact that they are strictly confined to a single surface of deposition. To fossils of this nature the author proposes to restrict the generic title of *Nemertites*.

Finally, the author describes some singular tracks apparently produced by Crustaceans belonging to the genus *Ceratiocaris*, and for which he proposes the generic name of *Caridolites*.

The following list comprises the species of fossils described in this communication:—

A. BURROWS.

I. Genus ARENICOLITES, Salter.
  1. *Arenicolites sparsus*, Salter.
  2. ——— *didymus*, Salter.
  3. ——— *robustus*, Nicholson.

II. Genus SCOLITHUS, Haldemand.
  4. *Scolithus canadensis*, Billings.
  5. ——— *linearis*, Hall.
  6. ——— *verticalis*, Hall.

III. Genus HISTIODERMA, Kinahan.
  7. *Histioderma hibernicum*, Kinahan.

IV. Genus PLANOLITES, Nicholson.
  8. *Planolites vulgaris*, Nicholson.
  9. ——— *granosus*, Nicholson.
  10. ——— *articulatus*, Nicholson.

B. TRAILS.

V. Genus CROSSOPODIA, M'Coy.
  11. *Crossopodia scotica*, M'Coy.
  12. ——— *lata*, M'Coy.

VI. Genus NEMERTITES, M'Leay.
  13. *Nemertites Ollivantii*, Murchison.
  14. ——— (*Palæochorda*) *major*, M'Coy.
  15. ——— (*Palæochorda*) *minor*, M'Coy.

VII. Genus MYRIANITES, M'Leay.
  16. *Myrianites tenuis*, M'Coy.
  17. ——— *Murchisoni*, Emmons.

C. APPENDIX.

VIII. Genus CARIDOLITES, Nicholson.
  18. *Caridolites Wilsoni*, Nicholson.

II.—REPORTS OF THE GEOLOGICAL SURVEY OF INDIANA, FOR THE YEARS 1870–71–72. By E. T. COX, State Geologist. Assisted by Prof. JOHN COLLETT and Dr. G. M. LEVETTE, etc. (Indianapolis, 1871, 1872. London: Trübner & Co.)

THESE Reports are contained in two volumes of 303 and 488 pages respectively, with accompanying maps, plans, sections, and other illustrations of the districts described, as well as tables of analyses of coals and other minerals, so as to make known their commercial importance. The Counties surveyed in detail in 1870 were chiefly Sullivan, Daviess, and Martin; and the following were surveyed in detail in 1871 and 1872, viz. Perry, Dubois, Pike, Parke, Ohio, Dearborn, and Switzerland counties, besides a preliminary examination of some ten or twelve others, from which a good general knowledge of their geology has been obtained, as well as the continuance of the Block or iron-smelting coal from the northern limits of the Indiana coal-basin to the Ohio river, a discovery of great advantage to the State, for this coal, which is unequalled for smelting iron, may probably induce the building of blast furnaces along the entire eastern margin of the coal-basin. In Indiana there are two well-defined zones (eastern and western), containing apparently some equivalent seams, yet the quality of the coal is quite distinct in each. The eastern area is about 450 square miles, and includes bituminous coals characterized, as non-caking or free burning; the *Block-coal* belongs to this series, and is so called from the facility with which it can be mined in blocks; it has a laminated structure, and is composed of alternate thin layers of vitreous dull black coal and fibrous mineral coal. The western zone comprises the greatest area, being over 6000 square miles, and contains three or more very thick beds of coal besides a number of thin ones. Its eastern boundary is formed by the zone of block-coal, but cannot at present be well defined; it appears however from the Report that the block-coal beds change in character, and pass into caking coal in going west.

From a general study of the Western and Indiana Coal-measures, Prof. Cox concludes that the Carboniferous rocks of the Appalachian and Western coal-fields were formed in two great depressions that gave rise to large inland seas, which communicated with the ocean on the south and west, and covered most of the southern states, as far north as the 35th parallel. A high ridge of Silurian rocks, capped in places with the Devonian, lying in a north-easterly direction across the states of Tenessee and Kentucky, and along the western border of Ohio, and the eastern of Indiana, separated these two seas from each other, and spreading over portions of the two latter states, extended into Pennsylvania, on the east, and Illinois and Iowa on the west, forming an unbroken chain along their northern shores. In these seas were formed the sub-carboniferous rocks, and, as the water became shallow from accumulated sediments, a barrier was formed, which shut out the ocean, and cut off the source of salt-water supply. By the further drainage of a large surface area, the water of these seas became less and less brackish, and the conditions necessary for the accumulation of the coal vegetation were, in this way, brought about so gradually that many marine forms continued to exist, and, by degrees, accommodated themselves to the new condition of things (p. 164). It is further inferred that these seas were of unequal depth, for the thickness of the strata in the two coal-fields is very different, the Appalachian being estimated at 2500 or 3000 feet, whereas the

Western coal-field will hardly exceed 1000 feet, and in Indiana not more than 700 feet.

The intercalated limestones and shales are replete with marine remains of fish, Cephalopods, Brachiopods, and Gasteropods, many of them even being specifically identical with British Carboniferous forms, an occurrence "which can scarcely be harmonized with the adopted 'bog or swamp' theory for the deposition of Coal and Coal-measure Limestones;" (p. 200) "for they indicate a home in the profound and quiet depths of a central ocean, remote from the influence of waves as well as from rocky or sandy bottoms, until some mighty current of disturbed and muddy waters, impelled by earthquake action, overwhelmed these animals—the impure water putting an end to their life, and burying them in the slimy bed deposited over the coal material." (Report, 1872, p. 201.)

These two volumes, which are chiefly occupied by descriptions of the Carboniferous rocks, contain also some useful and interesting notices of the Quaternary deposits, as well as of the agriculture, botany, and economical substances of the districts surveyed.

REVIEWS.

I.—THE GEOLOGICAL EVIDENCES OF THE ANTIQUITY OF MAN; WITH AN OUTLINE OF GLACIAL AND POST-TERTIARY GEOLOGY, AND REMARKS ON THE ORIGIN OF SPECIES, WITH SPECIAL REFERENCE TO MAN'S FIRST APPEARANCE ON THE EARTH. By SIR CHARLES LYELL, Bart., M.A., F.R.S. Fourth edition, revised. 8vo. pp. 572. (London: John Murray, 1873.)

NO man, during a long career as a scientific writer, has ever enjoyed a more well-deserved popularity or held a higher position as the exponent of modern geological thought and discovery than Sir Charles Lyell.

His books have been widely circulated and largely read. Even his "Antiquity of Man"—to some extent a diversion from his previous writings, and forming as it were an advanced post in a new region (the Quaternary Period) about to be annexed to Geological Science—met with the same warm and ready reception by the public.

Thus we find that the first edition, which was published in 1863, was followed by the second two months later, and by the third edition before the end of the year! Such a run of popularity required an interval of rest and recuperation; accordingly we find a period of ten years has now elapsed since the publication of the third edition—a period rich in varied and additional proofs of Man's antiquity. These, so far as the author has been able to collect and compress them into the small number of pages added to the fourth edition, will be found duly arranged and enrolled in the present volume.

The author has divided his book into three distinct parts, the first of which, called the "Antiquity of Man," might with more propriety (he thinks) have been distinguished as the "Geological Memorials of Man." The introduction, into the second part, of "the Glacial riod" was looked upon formerly as irrelevant to the subject of ın's antiquity; but Sir Charles Lyell now thinks there is good ound for its retention in such a work, seeing that now so much scussion is going on as to the pre- or post-glacial age of man.

He thinks the third part, treating of "the Origin of Species with ference to Man's place in Nature," is the obvious conclusion to the her parts of the inquiry.

The works of Sir John Lubbock on "Prehistoric Man," and that Mr. John Evans on "Ancient Stone Implements," have furnished uch new material and many suggestions to the author.

The theory proposed by Mr. Geikie, and adopted by Sir Charles yell, of the rise of land in Scotland to the extent of twenty-five et in Post-Roman times, he has now abandoned as being no longer nable. The evidences and arguments which have resulted in the mplete refutation of this theory have been published from time to ne in the pages of this MAGAZINE.[1] The occurrence of Roman ads and fords suited to the present sea-level and the discovery of Roman inscription on a stone at Bo'ness leave no doubt that the esent level of the land nearly corresponds with that in Roman times.

The interesting researches of M. E. Dupont in the caverns of the lley of the Lesse, where this river joins the Meuse, have been corded in this edition. Out of forty-three caves examined, 25 ntained traces of man. They are divisible into—(1) the Mammoth eriod; (2) the Reindeer Period; (3) the Neolithic, or polished one period, which is, however, more feebly represented than the her two.

The careful researches of Mr. Pengelly into the Brixham Cave at orquay, and the evidence he has accumulated in order to establish ıe accuracy of the Rev. Mr. MacEnery's statements in regard to e discovery by him of *Machairodus* teeth in January, 1826, have d to the exhumation of further remains in July, 1872, together ith other precious relics, which are duly chronicled.

Much has been written by Lyell and others regarding the cave of urignac, but from the author's last visit, in 1872, accompanied by r. T. McK. Hughes, now Woodwardian Professor at Cambridge, satisfied himself that the evidences of the remoteness of the era which the existence of sepulchral rites may be carried back are ore doubtful than M. Lartet and he had formerly supposed.

Sir Charles has also visited with Mr. Hughes the caverns of the ordogne, and has given some account of these interesting prehistoric fuges and of their buried contents.

Of the two men who undertook the exploration of these caves and ıe publication of the "Reliquiæ Aquitanicæ"—Messrs. Lartet and hristy—both are now dead; but the work is again in progress wards completion, a new part (edited by Prof. T. Rupert Jones, .R.S.) having just appeared, and another is promised before long.

The discovery by M. Rivière of the human skeleton in the cave Mentone (see GEOL. MAG., 1872, Vol. IX. p. 272, with an engrav- g, and p. 368) is of course duly recorded (p. 143):—

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[1] GEOL. MAG., 1865, Vol. II., p. 76, p. 181; 1866, Vol. III., pp. 266, 323, 425; and 1870, Vol. I., p. 270.

"The skeleton is that of a man about 5 feet 9 or 10 inches high, and all but perfect.

"The skull was of a red colour, and covered with numerous perforated marine shells, of the species of *Nassa neritea*, and twenty-two perforated canines of the stag, the whole having probably been a chaplet. A bone instrument, pointed at one end, lay across the forehead.

"The skull was very dolichocephalic, the occiput much produced, the forehead rather narrow, and the temple flattened; the facial angle measured from 80° to 85°. All the teeth were perfect, but were worn flat, as if by trituration of hard food, as is commonly observed in very ancient skulls, as well as in modern savage races.

"The thigh-bones were strongly-carinate, and the tibia, or shin-bone, was somewhat platycnemic, or flattened; the fibula also was of enormous thickness.

"The whole attitude indicated that the man had died in his sleep; and from the manner in which his remains were associated with unpolished implements and the bones of extinct animals, it seems not improbable that Dr. Rivière has brought to light a complete human skeleton of palæolithic age." (p. 144.)

Since the foregoing was printed, the author has learned that a second skeleton has been brought to light by M. Rivière in a neighbouring cavern under similar conditions. In a letter to the author (April 17, 1873), he states that he found with this second human fossil, a flint lance, and a flint hatchet, both unpolished.

Around the arms, wrists, and knees were bracelets of Mediterranean shells, *Nassa*, *Cypræa*, and *Buccinum;* and the skeleton and surrounding earth were stained red by oxide of iron, as was the case with the skeleton discovered in 1872. Extinct animals were also found at a higher level than this second skeleton; but from letters received from Mr. Charles Moore, F.G.S., who is now at Mentone, it may be inferred that the time of inhumation of these remains of elephant, rhinoceros, and cave-bear, in subaërial breccias at different altitudes in the cliffs, will have to be critically ascertained before their geological bearing on the age of the human skeletons can be finally settled. (Preface, p. vii.)

Dealing with the period immediately preceding that in which we have positive traces of man, the entire chapter on the Crags of Norfolk and Suffolk has been re-written by the author, who has incorporated the information recently published by Messrs. Prestwich, Gwyn Jeffreys, Searles V. Wood, senr. and junr., and F. Harmer.

Under the head of the Glacial Period, new light has been obtained from the observations of Dr. Nordenskiöld, whose valuable paper on Greenland, translated from the original Danish, was published in the GEOLOGICAL MAGAZINE last year.

In the 3rd part the author has added the new facts relating to evolution derived from the class Aves and Reptilia. That last instance of a remarkable dentigerous bird from the London Clay of Sheppey (*Odontopteryx toliapicus*), brought forward by Prof. Owen at the Geological Society on the 25th of June last, was not of course known to Sir Charles Lyell.

From the final page, under the heading "Transmutation and

Natural Theology," we cull the following paragraph, with which we must conclude our present notice:—

"The whole course of Nature may be the material embodiment of a pre-concerted arrangement; and if the succession of events be explained by transmutation, the perpetual adaptation of the organic world to new conditions leaves the argument in favour of design, and therefore of a designer, as valid as ever; 'for to do any work by an instrument must require, and therefore pre-suppose, the exertion rather of more than of less power, than to do it directly.'[1]

"As to the charge of materialism brought against all forms of the development theory, Dr. Gray has done well to remind us that 'of the two great minds of the seventeenth century, Newton and Leibnitz, both profoundly religious, as well as philosophical, one produced the theory of gravitation, the other objected to that theory, that it was subversive of natural religion.'"[2]

II.—Illustrated Guide to the Fish, Amphibian, Reptilian, and Supposed Mammalian Remains of the Northumberland Carboniferous Strata. By Thomas Pallister Barkas, F.G.S. 8vo., pp. 117 and folio Atlas. (London: W. M. Hutchings, 5, Bouverie Street).

MR. BARKAS, who is well known as an enthusiastic collector of Coal-measure fossils, has here reproduced in book-form the substance of a series of papers descriptive of the vertebrate remains found in the Newcastle Coal-deposits, originally contributed by him to the pages of *The Colliery Guardian*, and other publications.

The author, who dedicates his book to the "Working Miners in Northumberland," does not claim for it a high scientific position, for in his preface he says that his "work does not in any sense pretend to be exhaustive of the subject upon which it treats, but is rather a preliminary monograph of the Carboniferous Fauna of one locality." Nevertheless it will be found a useful "Manual" or "Guide," inasmuch as he brings together, under one cover, information which would otherwise have to be sought for in many publications, and it will well serve the worker or student of these remains as a book of ready reference. The descriptions of the fossils are mostly generic and brief, but they are concise; and the references to the various works in which more detailed descriptions are given are numerous. Any work on the Palæontology of a single deposit, and in a circumscribed area, even if it treats of all the fossils found therein, is of necessity limited in its scope, but very much more so when its subject is limited to one division—and that the Vertebrata of a Palæozoic deposit. We felt somewhat surprised at the number and variety, both of genera and species, here recorded as having been found in a comparatively limited area; for Mr. Barkas enumerates no less than twenty-eight genera of Fishes, containing forty-four species, and fourteen genera of Reptiles (*Amphibia*), exclusive of undetermined remains, from the Coal-beds of Newcastle, the larger proportion of which have been discovered within the last few years.

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[1] "Natural Selection not Inconsistent with Natural Theology," p. 55. By Dr. Asa Gray. Trübner & Co., London.
[2] Ibid, p. 31.

We wish Mr. Barkas had inserted, in addition to the list of genera, a list of all the *species* of vertebrate remains found in this locality, believing that these numbers would be considerably added to; should his book reach a second edition, we trust this important defect will be remedied.

On referring to the last edition of Prof. Morris's Catalogue of British Fossils, published in 1854, we find only twenty-nine genera, containing sixty-four species, of Fossil Fishes recorded as then known in the whole of the Coal-measures of Great Britain and Ireland; and many of these are entirely wanting in the Northumberland beds.

The only reptilian genus there recorded (*Parabatrachus*) is now cancelled; for the specimen upon which it was founded, which is preserved in the British Museum, has been long known to be the inner view of the maxillary of *Megalichthys.*

Of the Fossil Fishes, *Climaxodus ovatus*, Barkas, a Carboniferous Limestone genus, was first discovered by the author in the Coal-measures, and was originally described by him in the pages of this MAGAZINE, Vol. V. p. 495; see also GEOL. MAG., Vol. VI. pp. 42, 381. Of the genus *Ctenodus* ten species have been founded by Atthey and others upon teeth or other remains from the Newcastle Coal-beds. *Ctenodus tuberculatus*, Atthey, is figured in GEOL. MAG., Vol. VI. p. 314, Pl. IX. This genus has an especial interest, owing to its close affinity to *Ceratodus*, a genus which first appears in the Trias and is now found living in some of the rivers of Australia.

Archichthys and *Orthognathus* have hitherto been recorded as found only in the Northumberland beds.

Of the *Amphibia* we have eight or nine genera which are here first described and figured; and the author believes that *Orthosaurus pachycephalus*, Barkas, are the remains of a true reptile. The species is founded upon a nearly perfect cranium, of which he gives excellent figures of the natural size. He says: "In general form and configuration, in the position of the orbits, in the absence of a parietal foramen, in the strength of the quadrate bones, in the freedom of the palate and vomer from dentition, and in the form of the maxilliary bones, the cranium of *Orthosaurus* very closely resembles that of a modern crocodile." Should these views be confirmed by further investigation, these remains will be important as being those of the first true reptile found below the Permian, for the natural position of Prof. Marsh's *Eosaurus* from the Coal-fields of Nova Scotia is still doubtful.

The so-called mammal jaw we pass by as scarcely worthy of notice: it is founded upon a fragment so imperfect and obscure that it is impossible to base any satisfactory determination upon it.

Two well-marked forms of *Ichnites* are described and figured from the lower sandstone of the Carboniferous Limestone of Northumberland.

The book is well printed, and is accompanied by an excellent atlas of ten folio plates, eight of which are folding, containing 250 figures. Many of these are of magnified microscopic sections, the others are of the natural size.

In conclusion, we think Newcastle is fortunate in having local men who not only collect, but can also well describe and illustrate what they collect; for besides our author, Messrs. Hancock and Atthey have written some most valuable scientific papers upon the vertebrates of the Carboniferous period obtained from the strata of this important Coal-producing emporium.

REPORTS AND PROCEEDINGS.

I.—Royal Institution of Cornwall.

THE spring meeting of the Royal Institution of Cornwall was held at Truro on Friday, the 16th of May. Dr. Jago, F.R.S., V.P., presided, in the absence of Sir John St. Aubyn, Bart., M.P., the President. The following papers were read:—

On the Detrital Tin-ore of Cornwall. By William Jory Henwood, F.R.S., F.G.S., sometime *Her Majesty's Assay-Master of Tin in the Duchy of Cornwall.*—This memoir contains a summary of observations made at intervals during the past five-and-forty years. Of the four districts into which the writer divides the field of his labours, the first extends from the Land's End to the eastern sources of the Hayle river; the second is included between the Camborne, Crowan, Wendron, and Constantine granite, and the eastern tributaries of Restronguet, a creek of Falmouth harbour. The third is bounded on the west by the Truro river, and the Gannel, and on the east by the Fowey and the lower part of the Camel. The fourth reaches from the eastern part of the third to the Tamar. Throughout Cornwall the water-shed is much nearer to the north than to the south coast. A short notice of the general characteristics of each district precedes particulars of the stream-works now or lately wrought. And here it may be remarked that the Land's-End region contains no fewer than eleven *logan rocks,* of which seven are in the single parish of Zennor, and amongst these three are so closely placed, that sufficient force applied to one moves them all. The first district includes the detritus explored at Bosworles, Penrose, Bejowans, Tregadgwith, Coldharbour, Tregilsoe, Marazion-marsh, and St. Erth. The second comprehends the Wendron Moors, which have been wrought from remote antiquity to the present time, the instructive works long, but we fear unprofitably, carried out by Mr. Joshua Fox, near Mawnan, as well as the productive deposit wrought at Carnon, and beneath the navigable part of Restronguet creek, together with its lateral extensions into the Perran Smelting-house creek (where a human skeleton was discovered some fifty years ago resting on the tin-ground at low-water mark, compressed by longitudinal and cross bars of wood and covered with rocks of quartz), as well as in the Perran Wharf Valley, where quantities of inflammable gas issued from the vegetable remains, which rested on the tin-bed. The third embraces Pentuan, the St. Austell, Luxullian, Lanlivery, St. Stephen's, St. Dennis, and Tregoss Moors, together with the interesting deposit at Treloy, in St. Columb Minor, were coins, celts, *fibulæ,* and a remarkable vessel of pure tin were found amongst the refuse of earlier streamers, within two miles of the ancient entrenchment at Irevelgue Island, where bones, recognized by Professor Owen as of the *Bos longifrons*, were some years ago discovered by Mr. Nicholls. The fourth district comprises the wild moorlands between Lostwithiel, Bodmin, Camelford, Callington, and Launceston. Tin-ore, like gold, found in stream-works, is always of superior quality to that afforded by mines. The entire produce of gold from the tin works of Cornwall during the present century has probably amounted to no more than a very few ounces; but no district, perhaps no single stream-work, has been utterly destitute of it, and all yet examined has been found of remarkable purity. The masses of "Jews House" tin, and the remains of ancient furnaces still discovered, from time to time, in various parts of Cornwall, have been found more frequently on the outskirts than in the heart of the stream tin districts. Of these a copious, but the writer fears by no means an exhaustive, list is given. In a conversation which took place at the annual meeting of the Institution in 1867, the writer expressed his belief that the disuse of certain and the substitution of other coinage towns showed that the produce of East Cornwall was much greater, and of West Cornwall much smaller respectively in past ages than of late. The *Stannary Roll*, 34th Edward I. (1305–6), presented to the Institution in 1870, by Sir John Maclean, and the official returns during the last year in which coinage duties were levied, show that opinion to have been well founded. Thus, from the festival of St. Edmund, 16th of November, 1305, to the Feast of St. Matthew, 21st of September, 1306, there were coined at—

Lostwithiel,	3,294	blocks of tin, which weighed	176·5	(avoir.) tons.
Bodmin	1,505	,, ,, ,,	83·	,, ,,
Truro	1,298	,, ,, ,,	68·6	,, ,,
Trynu ?	694	,, ,, ,,	36·3	,, ,,
Helston	105	,, ,, ,,	6·1	a year,
	6,896	,, ,, ,,	370·5	
or at the rate of about			437	,,

At that time the blocks weighed, on an average, 120lbs., and the rate of coinage duty levied was forty shillings (£2) sterling per one thousand pounds weight of (metallic) tin.

From Midsummer, 1837, to Midsummer, 1838—the last year in which duties were paid to the Duchy of Cornwall on the coinage of tin—the quantities of metal coined at the various privileged towns were, at—

Calstock,	393	blocks of tin, which weighed some	70	(avoir.) tons.
Truro,	10,297	,, ,, ,,	1,860	,, ,,
Hayle,	5,452	,, ,, ,,	980	,, ,,
Penzance,	12,423	,, ,, ,,	2,250	,, ,,
	22,565	,, ,, ,,	5,160	a year.

Each block weighed at that time rather more than 400lbs. During many years the Duchy levied a duty of 4*s.* per 120lbs. on all tin produced in Cornwall, and of 1*s.* 6¾*d.* per 112 lbs. on all tin produced in Devonshire. In 1837–8, therefore, the produce of Cornwall was nearly twelve times as much as it was in 1305–6, and Mr. Hunt's valuable statistics show that since 1838 it has still further increased. The writer refers to the works of every author who has preceded him on the same subjects, and mentions in his notes many particulars which bear on numerous cognate matters of interest, for, having lived amongst the engineers and mine agents of a past generation, he is now almost the only surviving repository of their experience.

The tin trade of Cornwall in the reigns of Elizabeth and James, compared with that of Edward I. By Sir John Maclean, F.S.A. The author had recently found two paper books of accounts which contained statements of the quantity of tin coined at the four authorized coinage towns in the county during the greater part of the reign of Queen Elizabeth and in the early part of that of James I. Whilst the toll in Cornwall was 40*s.* per 1000 lbs., in Devon it was 15*s.* 7½*d.* only for the same weight. Whilst the tin-producing districts in those reigns had greatly changed, the produce had remained much the same as in the reign of Edward I. (1305). In the latter period the average annual yield was 991,979 lbs., and in 1305 the product was 865,562 lbs. Considering the great difference in the value of money at the two periods, it was obvious that the revenue derived by Elizabeth from the stannaries of Cornwall was far inferior to that of her distant ancestor. The two coinage towns in the east of Cornwall in 1305 were Lostwithiel and Bodmin. The tin weighed in that year in those two towns, which represented the quantity raised in the stannaries of Black Moor and Fowey Moor, was 616,686, as compared with 248,876 lbs. (including the weighing at a place which was read as Trynu, presumed to mean Truro), weighed at Truro and Helston. It was remarkable that at the latter place there were only two weighings in that year, amounting in the aggregate to 13,644 only. The average annual production of the two eastern stannaries is represented by the coinage at Lostwithiel and Liskeard, which latter place had been substituted for Bodmin in the reign of Elizabeth, during the period of 40 and 50 years. Embraced in the later accounts was 135,837 lbs. only, as compared with 807,299 lbs., the production of the two western stannaries of Tywarnhail, Penwith and Kerrier. The coinage usually took place twice in the year, viz. in June or July, and in September or October. The tin weighed at Bodmin in 1305 was 166,329 lbs.; at Lostwithiel, 450,357 lbs. in 1305, and 69,290 lbs. in 1607; at Liskeard, 79,160 lbs. in 1577, and 35,010 lbs. in 1607; at Helston, 13,644 lbs. in 1305, and 454,372 lbs. in 1607; and at Truro, 153,843 lbs. in 1305, and 426,492 lbs. in 1607. Mr. Henwood mentioned that in addition to the dues of 1*s.* 6¾*d.* per 112 lbs. in Devon, and 4*s.* per 120 lbs. in Cornwall, the Duchy used to receive other sums charged as "*great pieces.*" No doubt this was a fine on persons who sent unmanageable blocks of tin.

On the Occurrence of Wood-tin Ore in the Wheal Metal Lode at

Wheal Vor. By William Argall, Esq. This variety of ore is rarely found in lodes, and never at so great depth as in Wheal Vor. Some six or seven years since traces of it were discovered in the mine 180 fathoms from the surface, and within the last few months more has been found 20 fathoms below this.

Papers were also read by Dr. Hudson, the Rev. Dr. Bannister, Mr. J. J. Rogers, Mr. E. Hearle Rodd, Mr. N. Hare, Dr. Barham, and Mr. R. N. Worth. The authors of papers and donors to the library and museum were thanked, and the services of Dr. Jago for presiding were acknowledged.

II.—GEOLOGICAL SOCIETY OF LONDON.

(1).—April 30, 1873.—Joseph Prestwich, Esq., F.R.S., Vice-President, in the Chair.—The following communications were read:—1. "On the Permian Breccias and Boulder-beds of Armagh." By Prof. Edward Hull, F.R.S., F.G.S., Director of the Geological Survey of Ireland.

In this paper the author describes certain breccias occurring in the vicinity of Armagh, which he referred, both on stratigraphical and physical grounds, to the Lower Permian series, considering them to be identical with the "brockram" of Cumberland, and the Breccias of Worcestershire and Shropshire. The lower beds rest on the denuded surface of the Lower Carboniferous Limestone, and consist of a breccia of limestone pebbles in a reddish sandy paste, sometimes becoming a bedded calcareous sandstone with pebbles. These beds, which are 10–12 feet thick, are overlain by soft rudely stratified conglomerate and Boulder-beds, of subangular and rounded blocks of grit, felspathic sandstone, vein quartz, and limestone. In some places the breccia graduates up into the overlying Boulder-beds, but sometimes its surface is eroded. These beds are overlain by Boulder-clay of the Drift period. Within the city of Armagh well-borings, etc., have revealed the existence of New Red Sandstone above the Breccia and Boulder-beds. In the author's opinion the only agent which could have brought the blocks of Silurian and Old Red Sandstone age found in the Boulder-beds from their place of origin is floating-ice. The author further referred to the extensive denudation which the Carboniferous beds have undergone in Armagh, and also alluded to the occurrence of beds of Permian age near Benburb, between Armagh and Dungannon.

Discussion.—The Chairman inquired whether in the Permian beds there were no limestone pebbles, such as in all probability would have been striated had they been of glacial origin.

Mr. Godwin-Austen remembered that at the Meeting of the British Association a *Palæoniscus catopterus* and an *Estheria* were produced which were thought to identify the Irish beds with analogous red beds on the other side of the water. He was not prepared to accept the beds to which the name of Permian had been applied as distinct in their origin from those below and above them, and therefore worthy of a distinctive name. The conglomerate bed of the Roth-todt-liegende was only a littoral deposit of that period, and a mere analogy of character did not prove identity of date, as the same parent rocks, when broken up at different times, would yield similar breccias and conglomerates. He regarded the Zechstein period as one of extensive lake systems, though with occasional incursions of salt water. The Red Sandstone deposits, as a rule, were in the west, formed in fresh water; and in more eastern districts, as in Russia, they were of salt-water origin. He agreed with Prof. Ramsay as to the climatal conditions of that period, and had in the West of England seen blocks of porphyry which had been deposited in the midst of small detritus, and these he thought could not have been transported by any other agency than that of ice.

Mr. Hopkinson mentioned the Permian breccias of the South of Scotland, which are overlain by a deposit of Glacial age, so similar to the breccia below as to be with difficulty distinguished from it.

Prof. T. Rupert Jones argued that without exact evidence, the mere character and constituents of the conglomerates afforded no sufficient criterion as to age. In reply to Mr. Godwin-Austen, he insisted upon there being direct evidence in Germany and elsewhere of a distinction between the Permian and Triassic series.

Prof. Hughes was most grateful to Mr. Godwin-Austen for attacking those difficult beds the Trias and the Permian. In the Vale of Clwyd, which he had recently been mapping, he had found it almost impossible to distinguish them. The bulk of the Permian fossils had by some authors been transferred to the Carboniferous, and in other respects this province had been severely trenched upon. Still, as the New Red Sandstone belonged to a lengthened period of denudation, there was ample room for change of climate. He did not, however, think that the occasional presence of large blocks in the drifted deposit was by itself sufficient proof of glacial action, as when once a block of stone was moved, the carrying power of water was very great. He did not agree with the author as to the exact parallelism between the English and Irish deposits; and cited an instance near Tebay of Permian conglomerates passing into Carboniferous limestone, and with no characteristic whatever of a glacial origin. He doubted, therefore, as to the application of a glacial theory to this formation.

Mr. A. Tylor inquired whether the beds might not be of some intermediate date between the Carboniferous and Quaternary, like certain Belgian beds of the same character which were possibly of Cretaceous age.

Mr. Blanford suggested the possibility of the beds being of sub-aërial origin. In Persia and Beloochistan, on the borders of what appear to be old lakes, is a vast accumulation of detritus, occasionally containing enormous blocks of rock, and sometimes ten miles in breadth, and of the character of a brecciated deposit. The thickness in places appears to be at least 1000 feet; and the whole of this deposit he ascribed to the wash on the shores of the lake. He pointed out that the old division of all geological deposits into primary, secondary, etc., was not applicable in India, and, in fact, offered obstacles to research.

Prof. Hull commenced his reply by reading a letter from Prof. Ramsay, who agreed with him that the beds in question at Armagh were of truly Permian age. He maintained, in opposition to Mr. Austen, that there was to be traced a great break between the Permian and Triassic strata. There was, according to his view, as great an unconformity between these beds as there was between the Carboniferous and the Permian. The lines of flexure and disturbance at the commencement and close of the Permian period had been in different directions, and had he thought led to some of the discrepancies mentioned by Prof. Hughes. He insisted on the correspondence between the beds at Armagh and those of Worcestershire and Shropshire. As to the difference between the old Permian drift below and the Quaternary drift above, it required to be seen to be appreciated, and was hardly susceptible of description. The old drift was, however, redder, and bore greater traces of stratification than the newer drift above. He could not regard the Permian Boulder beds as belonging to the New Red Sandstone, by which they are, in fact, overlain at the city of Armagh itself. A few limestone pebbles had been found in the old Boulder beds, but none of them striated; but he did not consider this circumstance as of much importance. His main point was the occurrence of Roth-todt-liegende beds in Ireland, where only the Zechstein had previously been known.

2. "Geological Notes on Griqualand West." By G. W. Stow, Esq., F.G.S.

The geological results of a journey made by Mr. G. W. Stow and Mr. F. H. S. Orpen from the Orange Free State into Griqualand West are communicated by Mr. Stow in this paper, with numerous carefully executed sections and a geological map based on the survey map prepared by Mr. Orpen for the Government. From the junction of the Riet and Modder Rivers (south of the Panneveldt Diamond-fields) westward to the junction of the Vaal and the Orange, over the Great Campbell Plateau to Griquatown, Ongeluk, Matsáp, Potgieter, the Langeberg, Witte Zand, and to Kheis and the Schurwe Bergen, the track traversed three degrees of longitude, but nearly 300 miles of road. The return route north-east to Mount Huxley and Daniel's Kuil, and eastward to Likatlong, on the Hart or Kolang River, was nearly as long, and its results form part of the present communication. A subsequent portion of the journey up the Hart, across to the Vaal, down the valley by the Diamond-diggings of Hebron and Klipdrift to the Panneveldt, will be treated of in another paper.

From the Modder, first south-westward and then westward, to the junction of the Vaal and Orange, the olive shales of the *Dicynodon*- or Karoo-series, traversed frequently by igneous rocks, form the country, and are seen in some places to lie unconformably on older rocks. The shales reach to the edge of the Campbell Randt, on the other side of the Orange River, and have been, it seems, formed of the débris of those old hills to a great extent. The oldest rocks of the locality are seen cropping out here and there in the gorges at the foot of the Randt, and consist of metamorphic rocks, greatly denuded, on which the massive and extensive siliceo-calcareous strata of the Great Campbell Plateau lie unconformably. These latter and the breccias of their slopes are coated thickly with enormous travertine deposits. Beyond the Plateau, at Griquatown, a long parallel range of jaspideous rocks comes out from beneath the Campbell Plateau, and present a wonderful group of yellow, brown, chocolate and red jaspers, with magnetic and other ironstone, and beautiful seams of blue and yellow crocidolite. The southern portion of this range has long been known as the "Asbestos Mountains" and the "Doornberg." Igneous rock-masses occur around Ongeluk, west of the Jasper range, and then bright-red jasper rocks crop up near Matsáp, succeeded to the west by the parallel quartzite range of Matsáp, and again by other bedded jaspers, which seem to lie in a synclinal of the quartzite rocks, which come up again in the Langeberg. These are succeeded by lower rocks, consisting largely of sandstone, grit, and quartzite, with more or less pervading mica, as far as the journey extended in the Schurwe Bergen, also parallel to the former ranges, The maximum thickness of the successive strata is calculated by the author at 24,000 feet; allowing for possible reduplications, the minimum is regarded as not less than 9000 feet. The details of stratification, successive upheavals, denudation, nature, and origin of the salt-pans, escarpments, river-valleys, and other features, were treated of by the author, who has supplied a very large collection of specimens illustrative of the phenomena observed in the line of march, and of his numerous sections, maps, and sketches.

Discussion.—Prof. Hull suggested making thin slices from the limestone with a view to microscopic examination, and offered to carry out this suggestion.

Prof. Hughes observed that by burning a limestone and suddenly plunging it in water, fossils previously invisible were sometimes manifested.

Prof. Rupert Jones pointed out some interesting lithological characters in some of the micaceous, jaspideous, and other rocks sent by Mr. Stow.

3. "On some Bivalve Entomostraca, chiefly Cypridinidæ, of the Carboniferous Formations." By Prof. T. Rupert Jones, F.R.S., F.G.S.

The larger forms of bivalved Entomostraca are not rare in the Carboniferous Limestone, and some occur in certain shales of the Coal-measures. Professors Phillips, M'Coy, and De Koninck have figured and described some specimens. The collections made by M. J. Bosquet, F.C.G.S. (Belgium), Mr. Joseph Wright, F.G.S. (Cork, Ireland), and Mr. J. H. Burrow, M.A. (Settle, Yorkshire), and submitted to the author and his friend Mr. J. W. Kirkby, have elucidated many obscure points in the history of these old Entomostraca. Other specimens from Scotland, Yorkshire, Derbyshire, and the Isle of Man, communicated by many friends, were treated of in this paper.

The *Entomoconchus* of M'Coy proves to have the Cypridinal characters of anterior sinus and gape; and, besides *E. Scouleri*, at least two species have been determined. A very closely related genus, *Offa*, has also been indicated. M'Coy's "*Daphnia primæva*" belongs to *Cypridina* proper; and twelve other Carboniferous species have been established. A modified form of carapace, without any exact modern analogue, characterizes the new genus *Cypridinella*, with seven species. De Koninck's genus *Cypridella* (restricted) has seven species; and a form intermediate to this and *Cypridina* is described as *Cypridellina*, with eight species. *Sulcuna* (with two species) is an exaggerated modification of *Cypridella*. *Cyprella* of De Koninck (restricted) has two species. The recent *Bradycinctus*, Sars, and *Philomedes*, Lilljeborg, appear to have their prototypes in the Carboniferous Limestone, with one species each. *Rhombina*, a new genus, is a less easily recognized Cypridinal form, with an Irish and a Belgian species.

The recent *Polycope*, Sars, belonging to a different family, and represented by three Carboniferous species, was the last described in the memoir; but *Cytherella*, belonging to an allied group, is known in the Mountain-limestone and Coal-measures; and *Leperditia*, *Entomis*, *Beyrichia*, *Kirkbya*, and other Palæozoic genera, abound, together with forms referable probably to *Cythere*, *Cypris*, *Candona*, etc., which will be treated of in a future paper.

Discussion.—Mr. Gwyn Jeffreys inquired as to the greatest depth at which recent marine Entomostraca had occurred. So far as he knew, they were abundant in the Littoral and Laminarian zones, and very scarce in the Coralline. He was not aware of their occurrence at a great depth.

Prof. T. Rupert Jones stated that in the Carboniferous limestone the Cypridinidæ requently occur in layers, but he thought these were deposited at no great depth, robably not more than 100 fathoms. The greatest depth from which he had seen Entomostraca from the Atlantic was upwards of 1000 fathoms. These, however, elonged to different genera from those which he had been describing. Their modern ongeners, though mounting to the surface in the evening, no doubt descended to onsiderable depths during the day.

(2).—May 14th, 1873.—Joseph Prestwich, Esq., F.R.S., Vice-President, in the hair.—The following communications were read :—1. "On the genus *Palæocoryne*, Duncan and Jenkins, and it Affinities." By P. Martin Duncan, M. B. Lond., F.R.S., V.P.G.S., Prof. of Geology in King's College, London.

In this paper the author referred to certain minute fossils from the Carboniferous rocks of Scotland, described by himself and Mr. Jenkins in a paper read before the Royal Society, as belonging to the Hydroida, and most nearly resembling the recent genus *Bimeria*, Wright. He stated that numerous specimens since received from the eological Society of Scotland threw some further light on the nature of these fossils, and showed especially that in all probability the base is not really cellular, but that he cellular appearance is produced by the growth of the real base of the polype over the cells of the *Fenestella* on which it grows. The author further described what he believed to be the mode of growth of this organism, as displayed in the new specimens.

2. "Notes on Structure in the Chalk of the Yorkshire Wolds." By J. R. Mortimer, Esq. Communicated by W. Whitaker, Esq., F.G.S. In this paper the author described a peculiar structure observable in chalk from Yorkshire and elsewhere, giving it a striated appearance. This structure had been ascribed by Dr. Mackie and others to slickensides. The author adduced reasons for doubting the mechanical origin of these striations, and argued that they are of an organic nature. He ascribed them to corals, and remarked that similar striæ occur in all limestone formations.

Discussion.—Prof. Duncan, though differing entirely from the author, had been struck with the reasons which he had for his surmises. He exhibited some specimens of recent West-Indian Corals, which offered at first sight much resemblance to the character shown in the Chalk. It was to be observed that no reef-building corals are occupants of the deep seas, in which there is little doubt the Chalk was deposited.

Mr. H. Woodward thought that in one or two instances a pseudomorph of a *Siphonia* might be discerned. He could not, however, accept the fibrous structure as organic. It appeared to him to result from mechanical causes.

Mr. Whitaker read a note from Mr. Judd, who held that these specimens were not due to any organic origin. The quasi-crystalline structures known as "cone-in-cone," or "beef," seemed to him closely related; and in the Yorkshire Chalk an incipient crystallization of this kind had been set up; and the fact of its existence subsequently developed by the solvent action of the water, without which it might have remained latent in the body of the Chalk. In one instance the fibrous structure of a portion of the shell of an *Inoceramus* was continuous with that of the matrix. Mr. Whitaker was glad that the author had called attention to the subject, and thought that all would go with him in doubting that the structure was due to slickensides. He mentioned the presence of similar striæ in the Chalk of Surrey. Another observer had called attention to the greater abundance of the markings in the neighbourhood of fissures than in the solid Chalk.

Mr. Evans mentioned the occurrence of similar structure in the Chalk of Hertfordshire. The portions of the rock in which it occurred are usually harder than the surrounding rock; and in some cases the structure might be seen to pass into that of the ordinary chalk. He considered it to be mainly due to chemical causes.

The Chairman suggested the desirability of analysis to determine whether there was any difference in the chemical constitution of the fibrous and non-fibrous chalk.

Mr. Forbes, referring to the possibility of this structure being due to crystallization, thought its occurrence in the harder parts of the chalk in favour of this view; chalk being a nearly pure carbonate of lime, might crystallize either as calcite or aragonite. The specimens in question showed no trace of the peculiar cleavage of calcite, but had a strongly developed fibrous structure resembling aragonite; and as this mineral is the most instable form of crystalline carbonate of lime, it would account for its subsequent amorphous condition. He thought as these specimens were more commonly found near joints, that pressure had also assisted in rendering this structure more visible, and that the structure itself might be accounted for by a combination of the forces of crystallization and mechanical pressure.

3. "On *Platysiagum sclerocephalum* and *Palæospinax priscus*, Egerton." By Sir Philip de Malpas Grey-Egerton, Bart., M.P., F.R.S., F.G.S. The two species of ossil Fishes noticed in this paper were described by the author in the 13th Decade of the Memoirs of the Geological Survey, published in 1872. They are both from the

Lias of Lyme Regis. He now described some new specimens which add to our knowledge of their characters. An example of *Platysiagum* shows the position of the dorsal fin, which is placed very far back, occupying a place opposite to the interval between the ventral and anal fins, and the form of the trunk, which is of nearly uniform depth from the occiput to the base of the dorsal fin. The structure of the dorsal fin was described in detail. The new specimen of *Palæospinax priscus* shows especially the position of the second dorsal spine, which is placed over the fiftieth vertebra, the first being on the 16th, the fish thus most nearly approaching the existing *Cestracion*, which it also resembles in its dentition. In other respects it seems to be most nearly allied to *Acanthias*.

Discussion.—Dr. Günther observed that the families of sharks were most sharply characterized, and especially that of the Spinacidæ was a very natural group. He did not in the instance cited doubt the absence of a separate anal fin, which was one of the characteristics of the Spinacidæ.

He drew attention to the fact that the spined-sharks showed several singular peculiarities with regard to their geographical distribution. Some belonged to the deep sea, and were found at a depth of 800 fathoms, while others were even more truly pelagic forms, and never approached the shore. Some were found both in the northern and southern hemispheres so similar that specimens from the British seas and from the Straits of Magellan and Australia could not be distinguished. This geographical distribution was of great importance in considering the palæontological aspect of such a case.

4. "On a New Genus of Silurian Asteriadæ." By Thos. Wright, M.D., F.R.S.E., F.G.S.

The specimen described showed the outline of a small Starfish, with a large disk and short rays, in a slab of Wenlock Limestone from Dudley. The outline of the ten rays was described as marked out by the border of small triangular spines, the other plates of the disk and rays being absent. Each ray was terminated by a stemlike multiarticulate process as long as the ray, from towards the extremity of which spring slender lateral processes, giving it a tufted appearance. This Starfish, which is in the collection of Dr. Grindrod, is named by the author *Trichotaster plumiformis*.

Discussion.—Mr. H. Woodward was somewhat doubtful as to the affinities of the specimen, the preservation of which appeared to him hardly sufficient for its specific determination, though of all men Dr. Wright was the best qualified for such a task.

(3).—May 28th, 1873.—Prof. Ramsay, F.R.S., Vice-President, in the Chair.—The following communications were read:—I. "The Glaciation of the Northern part of the Lake-district." By J. Clifton Ward, Esq., F.G.S.

The author stated the leading questions to be settled by his investigation of the northern part of the Lake-district as follows:—The fact of the glaciation of the district being granted, (and of this he adduced abundant evidence,) the questions that arose were whether the glaciating agent worked from north to south, whether it came from within or from without the district, and finally, whether the agent was floating ice, a system of local glaciers, or an unbroken ice-cap. As the result of his investigation, he maintained that there is no evidence that a great ice-cap from the north ever swept over this district. The ice-scratches trending along the principal valleys, but sometimes crossing watersheds, indicate a great confluent glacier-sheet, at one time almost covering a great part of the district, the movement of which was determined by the principal water-shed of the Lake-district. In the part of the Lake-district under consideration the ice, during its increase, carried forward, from south to north, a great quantity of rocky material. There are no signs in the district of the occurrence of mild periods during the epoch of primary glaciation, but the author thought that the climate had probably become moderate before the great submergence of the land commenced. The author noticed the effect of the submergence upon the results of previous glacial action, and maintained that when the land had sunk 800 or 900 feet there was a recurrence of cold, and boulders were transported by floating ice. Until the submergence reached 1500 feet there was no direct communication between the northern and southern halves of the Lake-district except by the Straits of Dunmail Raise. From the directions which would be taken by the currents in the sea at this period, it would appear that boulders may then have been transported by floating ice in some of the same directions as they had previously been carried by glacier-ice. The extreme of submergence appeared to have been about 2000 feet. The author further maintained that on the re-elevation of the district there was a second land-glaciation, affecting the higher valleys and clearing them of marine drift.

DISCUSSION.—Mr. Campbell expressed his general agreement with the views of the author, though he was not acquainted with the particular district described. The only question was, whether the valleys had been filled to such an extent by water or by ice. He was rather inclined to consider the phenomena quite as much in accordance with a general ice-cap as with a submergence such as that suggested.

The Chairman complimented the author on the careful manner in which he had worked out his subject. He thought, however, that many of the principal features described had already been sketched out, though no doubt much knowledge had been added as to details. As to the question of general glaciation, he thought it probable that much of the northern part of Europe had at one time been coated with ice, and to such an extent that it occupied the greater part of the bed of the shallow seas. But even if there were this great ice-sheet, and the general direction of its flow was from north to south, yet there might in the body of the ice be upper and undercurrents, going to a certain extent in opposite directions, and mainly guided by the surface configuration of the ground beneath. He thought that some trace of this might be found in existing alpine regions, and that, especially in deep valleys, the upper portion of the ice must of necessity have had a tendency to pass over that which occupied the bottom of the valley. With regard to oscillation of temperature and of level, he agreed with the author, and was glad to find that his views as to a submergence of about 2000 feet so nearly corresponded with his own. So long as marine remains were found from stage to stage in a certain class of deposits, the probability of similar deposits at a higher level being also marine, was so great that it almost amounted to certainty. He considered that the importance of the latter part of the Glacial period was liable to be underrated, but it was well evinced by the depth (in some cases amounting to 1400 feet) to which some valleys, such as those of North Wales, appeared to have been filled with ice after the re-emergence of the land.

Mr. Ward, in reply, stated that, though he had found striations to a height of 2000 to 2500 feet, he had not found them on the highest summits of the mountains, where, on the hypothesis of a general ice-sheet, they ought to have occurred. He was therefore not at present prepared to accept the ice-cap theory. In illustration of Prof. Ramsay's view as to the late glacial deposits, he instanced some of the moraines at a high level in the Lake-district, which belonged to the period when the land was still submerged to a depth of 1300 feet or so, and when the cold climate was again supervening.

2. "Alluvial and Lacustrine Deposits and Alluvial Records of the Upper Indus Basin." By Frederic Drew, Esq., F.G.S.

First stating that the alluvium of that country had been noticed by several travellers, especially by Major Godwin-Austen, who had given much important information about them, the author said that he felt the necessity for a careful classification of the phenomena of alluvial deposits, for the want of recognition of the different kinds was likely to lead to incorrect deductions; the classification he proposed was the following:—

I. *Loosened material*, which consisted of disjointed rocks or loose angular stones, sometimes mixed up with mud, which had been separated and disintegrated, but since that had remained *unmoved*.

II. *Taluses*, the substance of which had fallen by its own weight, and not been transported by streams. These were the great heaps of angular matter that were found at the foot of cliffs, with a slope generally of near 35°. A special form was the fan-talus, which occurred where the falling matter had either originated from, or collected to, one spot, from which again it spread, and made a partial cone of the same slope as the ordinary taluses.

III. *Alluvial Fans.*—These were the fan-shaped extensions of alluvial or torrential matter that spread out from the mouths of gorges, where these debouched into a more open valley. They were in form cones of a low angle, commonly of 5° or so; they had accumulated by layer after layer on a cone-shaped surface, as shown by the radial sections exhibiting layers of a straight slope, and the chord sections showing curves, which were by the theory hyperbolas. Many complicated phenomena were produced by the denudation of these fans, and the production of secondary ones, some of which were illustrated by diagrams.

IV. *Alluvium*, which was defined as a deposit which sloped down the direction of the valley of the stream which had made it, and did not appreciably slope or curve over in a direction at right angles to that.

The alluvium of the country in question consisted mostly of pebble-beds, well stratified; it was common at all heights, from 16,000 feet or more downwards Sections of some 100 feet thick were to be observed at intervals along the valleys of most of the rivers: one of 500 feet was described as occurring near Sumkiel, in Rupshu; and 200, 300, and 400 feet heights of the alluvial terraces above the rivers were very general.

In a few cases there were wider openings, filled with similar deposits. The tableland of Deosaï, where the alluvium made flats at an elevation of 12,500 and 13,000 feet, surrounded by a ring of mountains of 16,000 and 17,000 feet high, was the most remarkable of these.

A special phenomenon was described as now and then occurring in the alluvium, namely, a sloping of the alluvial strata, looking at first like false-bedding on a large scale; and, further, a curving or bending of them, till they reached round even beyond the perpendicular. This the author attributed to the ploughing of the foot of a glacier against the alluvium that had been formed in front of it by its own streams.

The last class of alluvial deposits would be the *lacustrine*; but a description of these was reserved for a future portion of the paper.

Summary and Inferences.—There was evidence of a succession of three states:—1st. The cutting of the valleys. 2nd. The accumulation of alluvial matter. 3rd. The cutting down of the streams through that alluvial matter.

Accumulation denotes an excess of supply of material from the rocks (by disintegration) over what can be carried away by the streams.

Denudation, or the cutting down of the streams through their alluvium (the lowering of their beds), denotes a deficiency of supply of material from the rocks as compared with the transporting power of the streams. Hence the author inferred that the period of great accumulation of these alluvial deposits was one of great disintegration of rocks, one of intense frost; in other words, it was the Glacial period, and that the denudation occurred when the cold lessened, and there came to be a smaller supply of disintegrated material.

The connexion of various glacial phenomena with the alluvium, such as the one described above, was taken to corroborate the inference that the greater deposits were made during the Glacial epoch.

Discussion.—Mr. Sowerby confirmed the observations of the author, and said that the phenomena described by him are not confined to the valley of the Indus, but that they occur in other parts of India.

Mr. Blanford remarked that the peculiarity of the region of High Asia is the enormous amount of alluvial deposits—enormous both as regards their thickness and the area they occupy. This peculiarity is rendered the more striking as the deposits are not concealed by vegetation. He remarked upon the absence of stratification in the fan-shaped and other deposits, and at the mouths of streams. He expressed himself not quite satisfied that glaciers were the cause of the contorted beds referred to by Mr. Drew. The accumulation of great masses of deposits 700—800 feet thick he thought was frequently due to landslips, and he stated that he had seen such extending to 200 feet in thickness.

Mr. Clifton Ward stated that he had frequently found it difficult to distinguish the deposits at the mouth of streams from true alluvial beds.

The Chairman remarked that the phenomena described by Mr. Drew were to be observed elsewhere than in the district where his observations had been made, and referred to examples both in this country and on the continent of Europe.

Mr. Drew briefly replied.

(4).—June 11, 1873.—Prof. Ramsay, F.R.S., Vice-President, in the Chair.—The following communications were read:—1. "On the Nature and probable Origin of the superficial Deposits in the Valleys and Deserts of Central Persia." By W. T. Blanford, Esq., F.G.S.

In this paper the author described the general characters of the superficial deposits of Central Persia, and noticed the physical geography and rainfall of that country. He described especially the desert plains of the interior of the country, the paucity and scantiness of the streams, most of which terminate in salt swamps and lakes, and the occurrence of vast slopes of gravel on the margins of the desert plains, covering up the junction of the latter with the surrounding mountains. The desert plains he regarded as in general the beds of ancient lakes. His general results may be summed up as follows:—Persia has undergone a gradual change from a moister to a drier climate simultaneously with the elevation of portions of its surface, resulting first in the conversion of old river-valleys into inclosed basins containing large lakes, probably brackish or salt. Then, as the rainfall diminished, the lakes gradually dried up, leaving desert plains. The amount of subaërial disintegration among the rocks of the high ground he considered to be in excess of the force available for its removal, the water which now falls only sufficing to wash the loosened materials from the steeper slopes into the valleys, and hence the valleys in the upper parts are gradually being filled up with coarse gravel-like detritus, just as their lower portions have been already hidden beneath lake-deposits.

Discussion.—Mr. Prestwich could hardily understand how, without a very close examination, it could be ascertained that there were no outlets from the plains which had been mentioned. If by any possibility there were such outlets, great difficulty would arise in accepting the theory. He was not quite satisfied as to the evidence of the thickness of the deposits on the slopes, and inquired as to the presence of organic remains.

The Chairman had been much struck with the paper, though it was confessedly a rapid sketch of the country. Persia might indeed be regarded as a typical example in an exaggerated form of what was taking place in all dry areas. There are scattered inland salt lakes and large tracts of desert sands, surrounded by immense mountain-ranges, suggestive of areas like those of the Dead Sea, the Caspian, and the Aral, in which the evaporation equalled the supply of water derived from the rainfall, and where in consequence the lakes were salt. In many cases such lakes had become filled with sediment, while others have absolutely ceased to exist from want of rainfall. As to the causes of the formation of the gravels, he agreed with the author that on so large a scale any ordinary river-theory appeared almost inapplicable, and he was content to confess that at present it appeared to him difficult to account for their existence. The history of the Oxus was well known, and its banks had been the scene of constant invasion and disturbance, though they had in early times been occupied by large populations. He thought that in old times the Oxus might have been banked up, like most rivers along which there is an extensive population, and that possibly it was in consequence of the giving way of such banks that its course had been altered. Its condition might, he thought, have been like that of the Po at the present day, the bed of which was now above the neighbouring plains, and which a few years' neglect would divert from its course, so as to cover the surrounding country with ruin.

The author, in reply, stated that from the small plains there were certainly no outlets, and that in all probability there was none also from the great central plain of Persia. This had indeed been barometrically surveyed in various directions, and it was found that a large part of its centre was at a lower level than any part of the surrounding country. The slope of gravel at the edges of the deserts usually rested on the lacustrine deposits; and though there was in some cases a difference of 2000 feet between their highest and lowest parts, it was impossible to speak with certainty as to their absolute thickness. He was not aware of any organic remains having been found in the deposits, but they had as yet been but little examined. Though the majority of the lakes were decidedly salt, there were two exceptions—the lake of Gotcha and that of Seistan. The greater portion of this latter was now a marsh, and though there was no outlet it was perfectly fresh. For this circumstance he was not prepared to account, but there appeared to be no doubt on the subject. With regard to the Oxus, there must have been a time before Central Asia was highly civilized, when the river ran freely through the country unconfined by artificial means; and he thought it possible that at that time its lower part afforded an outlet from the sea of Aral to the Caspian. With a greater rainfall he thought the water of the sea of Aral would find its way along the old course of the Oxus into the Caspian Sea.

2. "On *Caryophyllia Bredai*, Milne-Edwards and Haime, from the Red Crag of Woodbridge." By Prof. P. Martin Duncan, M.B., F.R.S., V.P.G.S.

The author recorded the occurrence in the Red Crag of the Woodbridge district of a variety of *Caryophyllia Bredai*, Milne-Edwards and Haime. The species was originally described from the Maestricht Chalk, and the specimen referred to, which was obtained by Mr. E. Charlesworth, appears to be a *remanié* fossil, derived from the uppermost beds of the Chalk, some traces of which still remain in the neighbourhood of Norwich.

Discussion.—Mr. Charlesworth made some comments on the difficulty of ascertaining the exact locality at which Crag fossils were found. He mentioned that in former years he had found Cretaceous fossils in the Crag; but from the matrix they contained, he had determined them to be derivative. He commented at some length on the liability to erroneous conclusions which might result to palæontology from this intermixture of remains belonging to different periods, and also on the errors which arose from too great a tendency to regard fossils as derivative when, like the cetotolites of the Crag, they actually belonged to the beds in which they occurred. He regarded the coral as derivative.

3. "On the Cephalopoda-bed and the Oolite Sands of Dorset and part of Somerset." By James Buckman, Esq., F.L.S., F.G.S.

In this paper the author discussed the true position of certain beds containing abundant remains of Cephalopoda, found in various parts of the Jurassic region of this country, and of the sandy bed underlying the Inferior Oolite at Cleeve Hill and other places (called by Prof. Phillips the "Midford Sands"), which has been regarded by most authors as belonging to the Lias. From an investigation of the Cephalopoda-bed in quarries at Bradford Abbas in Dorsetshire, the author comes to the conclusion that it is quite distinct from the Cephalopoda-bed of Gloucestershire, and that it is the representative of the Rubbly Oolite at the top of Leckhampton Hill and Cold Comfort, and of the Gryphite and *Trigonia*-beds of the neighbourhood of Cheltenham. The Gloucestershire Cephalopoda-bed he regards as situated close to the bottom of the Inferior Oolite series; and this is also the position to which he refers the sandy beds above mentioned.

Discussion.—Prof. Duncan, though accepting zones as useful in stratigraphical arrangement, agreed with the author that they could not be used for fixing hard and fast lines of demarcation.

Mr. Evans pointed out that the main question at issue was whether the sandy beds below the Cephalopoda-bed of Bradford Abbas were really the equivalents of those which were found above the analogous bed in Gloucestershire.

The Chairman regretted the absence of Fellows more especially interested in this question. For himself, he regarded it as impossible to correlate particular zones over any large area, and thought that the whole series might be considered as passage-beds, the order of which might vary even within a limited distance.

4. "*Cetarthrosaurus Walkeri* (Seeley), an Ichthyosaurian from the Cambridge Upper Greensand." By H. G. Seeley, Esq., F.L.S., F.G.S.

In this paper the author described a small Ichthyosaurian femur, discovered by Mr. J. F. Walker in the Upper Greensand of Cambridge. He noticed the general characteristics of the femur in Ichthyosaurians, and pointed out, as the chief peculiarities of the bone that he was describing, the subovate form of its head, and the presence of large flattened lateral trochanters, which, if of equal dimensions on both sides of the bone, would have made its greatest transverse measurement greater than its length. Upon this bone he proposed to found a new genus, *Cetarthrosaurus.*

Discussion.—Sir P. Egerton was inclined to regard the trochanters as vertical rather than as lateral.

Mr. Seeley remarked that in calling the two trochanters lateral, he was guided by the position in which it appeared to him that the limbs were carried during the life of the animal.

III.—Geologists' Association.

Excursion to Charlton, April 26th.—The well-known section showing the junction of the English Secondaries and Tertiaries was visited by a very numerous party, under the direction of Prof. Morris, who, in an excellent lecture, described the Chalk and the Lower Eocenes, with their foreign equivalents. Leaving this section, the Professor conducted the members to that nearer the town of Woolwich, which well displays the Shell-beds of the Woolwich and Reading series, with Thanet Sands below, overlying the Chalk. *Ostrea* and *Cyrena* form the great mass of the Shell-beds, but the genera *Melania* and *Cerithium*, especially the former, are well represented.

Excursion to Aylesbury, May 5th.—Prof. Morris, in the unavoidable absence of Mr. W. Whitaker, B.A., conducted the party. The Hartwell exposure of the Kimmeridge Clay, yielding *Ammonites biplex* and *Astarte Hartwellensis*, was first visited, and afterwards the fine sections of Portland, Purbeck, and Neocomian beds in the neighbourhood of Hartwell and Stone. Many fossils were obtained.

Excursion to Eastbourne and St. Leonards, May 23rd and 24th.—Directors, the Rev. E. S. Dewick, M.A., F.G.S., and Mr. John Hopkinson, F.G.S. On arrival at Eastbourne, the party visited the Museum of Eastbourne College, and afterwards the Caldecott Collection, and that of Dr. Ogier Ward. During the afternoon, an exposure of Alluvium overlying the Gault at "the Wish" was seen, and the fine coast section extending to Beachy Head, showing the Upper Cretaceous series, examined. On the following day, Bexhill and St. Leonards were visited, and under the guidance of Mr. J. E. H. Peyton, F.G.S., the members had opportunities of studying sections of the Weald Clay, Tunbridge Wells Sands, Wadhurst Clay, Ashdown Sands, and the Ashburnham Beds. The members of the Association were most hospitably entertained by Mr. Roper at Eastbourne, and Mr. Peyton at St. Leonards.

Excursion to Finchley, May 31st.—Director, Mr. H. Walker, F.G.S. At East End, the effect on the physical features of the neighbourhood produced by the Glacial deposits was pointed out, and by the aid of an enlarged Survey Map of the district, a copy of which was given to each member of the party by Mr. Walker, the area of these deposits was seen to be triangular, with Muswell Hill, Hendon, and East Barnet indicating its extent. At the Marylebone Cemetery a large number of fossils from the Drift were seen, and at the Manor brickfield a good exposure of the great Chalky Boulder-clay was examined. Mr. Walker explained its relations and the conditions of its deposition, and then conducted the party to the high ground near Finchley Station, where Mr. Caleb Evans, F.G.S., described the physical geology of the northern parts of Middlesex, and exhibited diagrams showing the extension and outcrop of the formations seen in the district.

Excursion to Brighton, June 11th.—Directors: the President, and Professor T. Rupert Jones, F.R.S. On arrival at Brighton, the party crossed the South Downs o the "Devil's Dyke," at the summit of the escarpment overlooking the Weald; and here illustrating his remarks by maps, showing the changes in the physical geography of this part of the globe, which have occurred during various geological epochs, Prof. Rupert Jones explained the theories which had been advanced to account for the denudation of the Weald. He first referred to the hypothesis of the upheaval of the elliptical area of the Weald causing axial and transverse fissures in the Chalk. This upheaval gave rise to several rivers running north, and corresponding ones running south, which now drain the Wealden area. The advocates of the sub-aerial denudation hypothesis maintain that the action of rain and rivers sufficed to complete the work of denudation; but it is contended, on the other hand, that it must have been consummated by submarine action. This latter opinion was strongly advocated by Mr. Mackie, who had very ingeniously shown the manner in which the sea would act, and form a long bay corresponding to the present Wealden area before the formation of the Straits of Dover. The Professor concluded his address by some general observations on the changes which had occurred in the physiography of this part of the globe. Mr. Woodward concurred in the opinion that Mr. Mackie's theory had scarcely received that careful consideration which it seemed to him it deserved, and adduced various phenomena that would be difficult to account for on the hypothesis of sub-aerial denudation alone. Returning to Brighton by way of the western valley and past Furze Hill, the area of the Tertiary Deposits, the party traversed the whole length of the coast section, and alighted at Kemp Town, to observe the "Elephant Bed," which was especially well seen, in consequence of a recent fall of a portion of the cliff. This remarkable bed, and the underlying 'raised beach" resting on the undisturbed Chalk, were very attentively examined. After luncheon, the new Museum (not yet opened to the public) was visited. The visitors were received by Mr. T. Davidson, F.R.S., Chairman of the Museum Committee. and Mr. G. Scott, the Curator; and the Davidson collection of foreign fossils and volcanic products, the Willett collection of Cretaceous fossils, and the contents of the Museum generally, were subsequently inspected. Mr. Woodward lucidly explained the general arrangement of the Museum, which he regarded with especial interest, as well as the great share which Mr. Davidson had taken in bringing together a collection which would be worthy of the important town of Brighton. Prof. Rupert Jones then discoursed on the Elephant Bed, attributing this great aggregation of Chalk debris against undisturbed Chalk to a "banking up" which would be produced by a reflex action of the tides, consequent upon the obstruction of the isthmus which then extended across what are now the Straits of Dover. After thanks had been duly tendered and responded to by Mr. Davidson, the members proceeded to the Aquarium, to visit which they had been very courteously invited. Thus, the remainder of the time at the disposal of the party was instructively and agreeably spent, and the return to London by the evening train concluded the day's proceedings.

ORDINARY EVENING MEETING.—June 6th, 1873.—Robert Etheridge, Esq., F.R.S., F.G.S., Vice-President, in the Chair.—"On Ammonite Zones in the Upper Chalk of Margate, Kent," by F. A. Bedwell, Esq., M.A. The author described, and showed by sections, the exact positions in the cliffs to the east and west of Margate, of fifteen large Ammonites, twelve of which lie between the Flagstaff and the Clifton Ville Hotel, a space of about half a mile, and some of them exceed three feet in diameter. All these twelve are in a bed closely approximating to an exact parallel with a faint line of nodular flints, which undulates over this part of the cliff, and are at a constant distance of eight feet below that line. From these facts were deduced the following inferences:—(1) The presence of an Ammonite Zone, and of (2) a true sea floor. (3) The parallelism of this, with the horizontal flints, and (4) that all the horizontal bands of flint must be assumed to have been aggregated before the Chalk moved. Particulars were also given of three other beds of Ammonites, one to the west of Margate, another forty feet below that first mentioned, and a fourth at Pegwell Bay, at the top of the cliff near the landing stage; and it was conjectured that the first and second are identical, and also the third and fourth. Specimens from the first and second beds were respectively identified by Mr. Etheridge as *A. leptophyllus* and *A. Lewesiensis*. Similar beds elsewhere were referred to, but details could only be given of one, which is to be seen at low water, near the Black Rock at Brighton. A remarkable bed of continuous solid flint, between three and four inches thick, extends round and under the Isle of Thanet. Between the Foreland and Pegwell Bay it is in the upper part of the cliff, while it sinks below the shore at Pegwell Bay and Kingsgate, rises again to the west at the back of Margate Harbour, but disappears immediately, appears again to the south as pointed out by Mr. Whitaker, in his "Geology of the London Basin," at Cap Point, near Walmer, and again at Shepherds Well station, ten miles inland, where it is surmounted by the soft, almost flintless, Chalk of Margate, and it is known throughout the island by the well diggers. This positive testimony of coincident and uniform flint aggregation over so large an area appears to be an important fact in its bearing on the origin of flint. Mr. Bedwell had found the Ammonites entirely by trusting to the zone of life theory insisted on by Mr. Caleb Evans in his paper on the Chalk (Geol. Assoc., 1870), and had failed to find them until he had selected the faint line of flints as a datum line, and worked from that. He advised all young students of the Chalk to examine a cliff in true horizons, and not in a mere indiscriminate effort to make a large bag of specimens; to record carefully the exact chronological order of each fossil extracted, by referring it to a datum line as suggested by Mr. Caleb Evans; to keep in mind the time which may have separated the life history of two fossils, though only distant a few feet from each other; and to try and correlate two sections of Chalk rather by the succession of zones of life in each cliff than by a mere comparison of indiscriminately collected fossils. The author, in conclusion, urged the importance of allowing Nature to teach her own independent lessons at the cliff side, of supplementing Nature by books rather than books by Nature, and pointed out how easy it was for those having but little knowledge of details to be of service to Science, by simply observing and following to its end one single thread, and one only, and then laying the results before scientific men, leaving them to estimate the value of the information.

CORRESPONDENCE.

NORTHERN DRIFT ERRATICS.

Sir,—I have lately been struck with the idea that geologists living in the midland and southern counties might like to compare the erratics of their own neighbourhoods with stones from the Boulder-clay of Cheshire, where the Northern Drift may be said to attain its central and maximum development. I have therefore resolved to devote next month (July) to the task of collecting small stones, striated and cross-striated stones, chips from large stones, etc., naming and assigning the parentage of specimens, and packing and sending off boxfulls to parties who may wish for them. There will be a small charge to cover direct and indirect expenses. Those who are interested in this subject would oblige by corresponding without delay.

Chester, *June* 13, 1873. D. Mackintosh.

FURTHER REMARKS ON *PTERASPIS*.

Sir,—I have lately succeeded in demonstrating the existence of real osseous lucunæ in *Pteraspis*, by preparing very thin horizontal sections from near the upper surface of the shield. The lacunæ are very minute, and form, by their ramifications, a dense net-work, very nearly resembling that in *Tolypelepis undulatus*, Pander (Monographie der fossilen Fische der Silurischen Systems, tab. 6, f. 24), from the uppermost Silurian strata of Oesel. I now regard that fossil as a portion of a Pteraspidian shield, and shall search for further information in that locality.

As regards the supposed connexion between *Pteraspis* and *Cyathaspis* on one side, and *Scaphaspis* on the other, the evidence furnished by Dr. Kunth's figures and description appear to me to be most satisfactory.

The specimen figured is the first Pteraspidian fossil ever detected in the numerous erratic Silurian boulders of Northern Germany, and is not selected from among a great number of similar fossils.

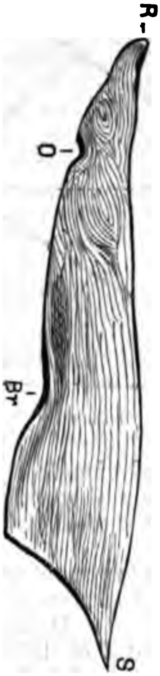
The two shields are not brought into contact accidentally, but correspond to each other most clearly in their size and in their mutual position.

The other fragments of similar structure occurring in the same piece of stone, probably represent the cornua and some of the scales.

St. Petersburg, Mag. F. Schmidt.
$^{15}/_{27}$ *May*, 1873.

NOTE ON *HOLASPIS SERICEUS.*

Sir,—Will you kindly insert the inclosed outline sketch of a lateral view of the shield of Holaspis, which exhibits the orbital notch in a way which was impossible in the view of the upper



Outline lateral view of the shield of *Holaspis sericeus*. *R*. Rostrum. *S*. Spine. *O*. Orbital notch. *Br*. Depression corresponding to the cornual perforation or branchial aperture of *Pteraspis*.

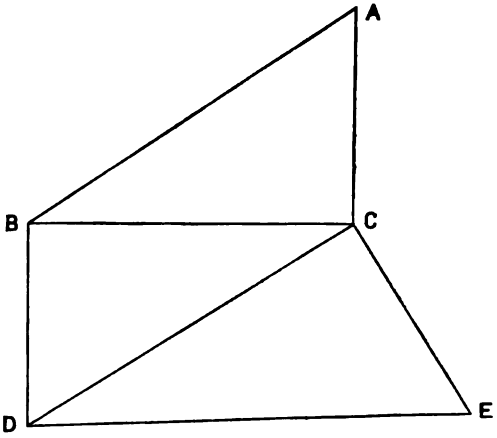
surface published in your last Number. Let me add that the striations, though rightly rendered as to direction in that lithograph, are not given with sufficient fineness or regularity. I may refer your readers to the plates of *Scaphaspis Lloydii* and the restorations of the shield of Pteraspis in my monograph for accurate reproduction of striations having the same character as those of *Holaspis*. It is especially with *Scaphaspis* that *Holaspis* agrees in the form and size of its skin-like grooving. E. Ray Lankester.

Oxford, *June* 18*th*.

GEOLOGICAL PROBLEMS.

Sir,—The following methods of finding by diagram, in place of calculation, certain data for the construction of correct geological sections, may be found useful.

Problem 1.—To find the apparent angle in any required section from the full dip, and the deviation of its direction from that of the section.



Construct the right-angled triangle *A B C*, with *A B C* equal to the full dip; also the right-angled triangle *B C D*, with *B C D* equal to the deviation; lastly the right-angled triangle *C D E*, in which *C E* is equal to *A C*.

Then *C D E* is the required apparent angle.

Proof.—If *A B C* be a vertical plane along the full dip, and *C D E* the vertical plane of section. *B C D* will be a horizontal plane, and *A C*, *C E* will coincide, so that *B D*, *A E* will be the plane of stratification, giving the apparent angle *C D E* along the section.

Problem 2.—From two apparent dips[1] to find the full dip and its direction.

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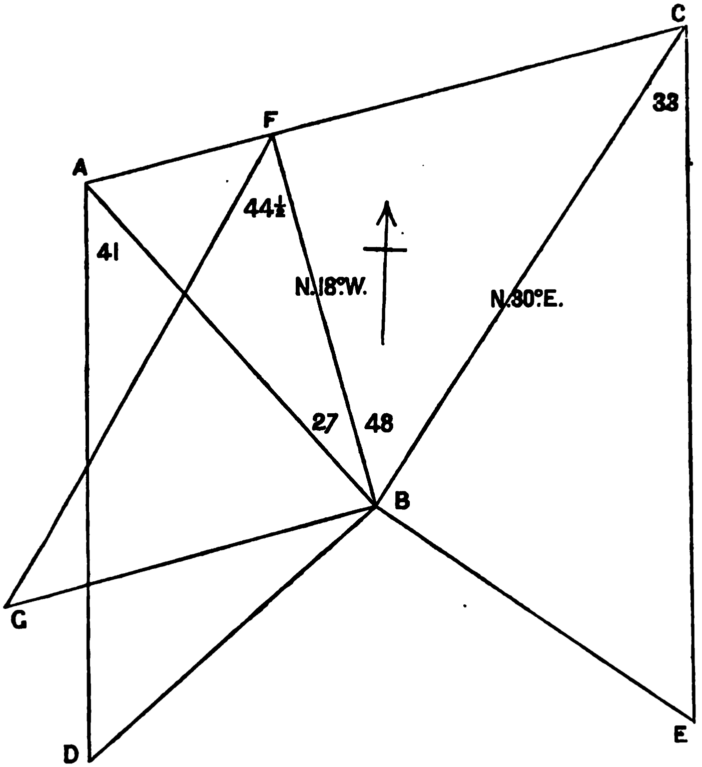
[1] Any three points, not being in a straight line, on a line of out-crop, will furnish

Suppose two apparent dips, 41° N.W. and 33° N., 30° E.



Result 44½° N. 18° W.

Draw *B A*, *B C* in the directions of the apparent dips: erect *B D*, *B E* vertical to *B A*, *B C* respectively, and equal to each other. From *D*, *E*, draw *D A*, *E C*, making *B A D*, *B C E* equal to the apparent angles whose direction is shown by *B A*, *B C* respectively. Join *A C*, and draw *B F* vertical to it. Draw *B G* parallel to *A C*, and equal to *B E*: join *F G*.

Then *B F* is the direction of the full dip and *G F B* its amount.

Proof.—If *A B C* be placed horizontally and *A B D*, *B C E*, *B F G*, vertically, *D*, *G*, and *E* will coincide, and *D A*, *G F*, *E C*, and *A C* will be in the plane of stratification giving the apparent angles at *A* and *C* and the full dip at *F*. In practice the triangle *B G F* might be more expeditiously constructed between *B F* and *A C*.

Problem 3.—Given a plane's dip and direction, to ascertain the effect on it of a secondary tilt of known amount and direction, and

three apparent dips, which may be taken two and two, thereby proving whether or no the stratum is a true plane, and if not, the mean of the three results will indicate the general dip.

on the other hand from the present position of the plane to calculate its original dip.

1st. Find by problem 1 the dip of the plane in the direction (*a*) of the secondary tilt and (*b*) of its strike.

2nd. Add or subtract (as the case may require) to or from (*a*) the amount of the secondary tilt (*n*).

3rd. From $a \pm n$ and *b* (two apparent angles) find the full dip and its direction by Problem 2.

Example.—A plane dips N. at 50°, and is subsequently tilted 49° to W. 30° S. Find its final position. Its original dip to W. 30° S. by Prob. 1, is by diagram —30¾°, by logarithms —30° 47′ (being that amount to E. 30° N.) and to N. 30° W., 45¾° (logs. 45° 54′).

After the secondary tilt the dips are W. 30° S. 18¼° (49—30¾) and N. 30 W. 45¾.

The resultant position being 47° to W. 42° N. or by logs. 47° 17′ to W. 42° 19′ N.

W. H. Dalton, H.M. Geol. Survey.

LABYRINTHODONTS OF THE COAL-MEASURES.

Sir,—At the last meeting of the British Association, in August, 1872, the following resolution was adopted:

"That Professor Phillips, Professor Harkness, Mr. Henry Woodward, Mr. James Thomson, and Mr. L. C. Miall be a Committee for the purpose of investigating and reporting upon the Labyrinthodonts of the Coal-measures; and that Mr. L. C. Miall be the Secretary."

The Committee has entered upon its work, and it is hoped that useful results will be laid before the Association from time to time. It has become clear that the preliminary investigation at least must not be limited to British Carboniferous Labyrinthodonts, but must include the Triassic genera as well as the Carboniferous examples discovered in other countries. The successful prosecution of the inquiry is therefore found to depend in part upon the assistance which can be rendered by geologists resident in different parts of the world.

I am instructed by the Committee to inquire whether you can aid us in any way. Casts and photographs of instructive specimens, drawings, if practicable, of full size, and measurements of such parts as can be clearly identified, would be specially valuable. The Committee will further be glad to receive any publications bearing on the subject, which may not be readily accessible in England.

Philosophical Hall,
Leeds, *May*, 1873.

L. C. Miall, *Secretary to the Committee.*

MISCELLANEOUS.

◆

Our Colonies—New South Wales. By **Charles Robinson.** 8vo. pp. 94. (Sydney, 1873.)

The Colony of New South Wales, Mr. Robinson informs us, is the oldest and richest of the Australian Colonies. It is only 103 years since Captain Cook planted the British flag on that distant Island-Continent, and only 85 years since England discovered the vast resources which this grand country contains, and recognized the possibility of establishing in New South Wales another branch of her industrious and enterprising people. There is now settled on these lands an English-speaking population of over 2,000,000 self-governing and self-dependent Colonists. Yet it was only on the 26th January, 1788, that the first governor, Captain Phillip, landed with his rough colonist band of 1,030 people, together with 431 head of live stock (cattle and poultry), all told.

In this very harbour of Port Jackson, one of the largest and most beautiful natural land-locked havens in the world, now ride the ships of all nations, and at its head stands the Capital City, Sydney, with its long streets, handsome buildings, and crowded warehouses. It has already given birth to two colonies as large as itself, namely, on the South, the Colony of Victoria (in 1851), taking from the older colony a population of 68,335, and 6,026,137 head of sheep and cattle; and in 1859, on the north, the Colony of Queensland, with a population of 25,000, and 2,419,091 sheep. Yet on 2nd April, 1871, the original Colony of New South Wales, in its present restricted form, possessed a population of 503,981, with 2,014,888 head of cattle, 16,278,697 sheep. 550 post-towns have been founded, 6,114 miles of telegraph opened, 10,000 miles of roads made, 400 miles of railway constructed, and 300 miles more in course of construction. Immense mines have been opened for the precious metals, and for copper, tin, coal, and other minerals.

Although the Colony of Victoria has won the reputation for possessing the richest gold-fields in Australia, the accounts now published of gold-mining and gold-washing in New South Wales,[1] promise to equal, if not to surpass, the younger Colony. The gold-fields comprise an area of about 13,656 square miles, and number more than 70 distinct fields. The richest are on the western side of the great dividing range. Although the Alluvial gold-fields are the oldest and most easily worked, the quartz-reefs, to which the attention of miners has of late been directed, are now proving very rich indeed. From two of the mines on Hawkins Hill or Golden Mountain during the last six months of 1872, gold to the value of £162,850 (after paying escort-fees and mint-charges) was obtained.

From another locality, Grenfell, one small company crushed 14,573 tons of stone at a cost of £1 per ton, including all expenses, obtaining a yield of 1 oz. 3 dwts. to the ton, or 16,481 ounces of gold, producing £60,000, or a clear profit in five years' time of £45,000.

Another Field, "The Emu Creek Gold-field," from 1866 (the date of its discovery to 30th September, 1871, has sent to Sydney Mint [illegible] ounces of gold of the value of £723,642.

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[1] Where gold was first discovered in Australia in 1851.

The richest mines yet opened are those known as Krohmann's Co. and Beyers and Holtermann's Co. A statement of results of less than a year's work furnished by these Companies is very remarkable:—

KROHMANN'S CO.	BEYERS AND HOLTERMANN'S CO.
Stone crushed about 446 tons: produced [illegible] ozs. Nett proceeds as per Mint returns £[illegible]	Stone crushed 415 tons: produce [illegible] ozs. Nett proceeds as per Mint returns £63,234 12s. 0d.

Coming, as these statements do to us, *authoritatively* from the Colonial Government of New South Wales, we cannot for a moment doubt their authenticity, nor can we but believe that a grand future lies before this Colony. Although but of small extent, New South Wales possesses a coal-field of its own, 34,720 acres being under lease for mining, with 2,150 pits. In 1871 the export of coal amounted to 565,429 tons, of the value of £256,690. With gold, coal, kerosene, iron, copper, tin, silver, lead, cinnabar, diamonds, excellent wheat-lands, pasturage, water, and timber, with a genial climate, and freedom from taxation! even the goodly land of Canaan could hardly have surpassed "The Queen of the Pacific," as her children (now happily freed from the injurious influence of the old convict system) may justly and proudly call her.[1]

GEOLOGICAL RESORTS AND LOCALITIES FOR FOSSILS AROUND LONDON.—The Londoner lives amidst geological scenes and memorials of remarkable variety. Our environs are rich in traces of former physical geography and past zoological worlds. In the Saturday afternoon excursions which are now so regularly organized for popularizing geology, the wonderful history of the ground beneath us, as revealed in

> Scarped cliff and quarried stone,

are delighting and instructing crowds of the newer generation of Londoners. The old rivers and seas which at successive pre-historic periods occupied the site of London and its vicinity, although they have long since receded or entirely disappeared, have left natural maps of themselves in the ground beneath us. They have left behind them their beds of mud or gravel to commemorate their former existence. It is these old sea-beds and river-gravels that now form the solid ground on which we are living, and hence it is that we find in them the shells and other remains which are known as fossils. Around London are numerous spots where we can descend into these old sea and river-beds, and see for ourselves the imbedded fossils. A list of these open sections is given in the "Saturday Half-Holiday Guide," edited by Henry Walker, F.G.S. (Kent & Co., Paternoster Row, and the Saturday Half-Holiday Committee, 100, Fleet Street, price *3d.*), together with a Map embracing an area of 25 miles round London, and 48 pp. of general information relating to routes, places, scenery, historical, archæological, zoological, geological, botanical, and other matters interesting to every one having a Half-Holiday.

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[1] Statistics of New South Wales, printed for the Government, accompanied by Maps of the Agricultural, Mining, and other resources of the Colony. (London: *Trubner & Co.)*

THE SASSO DI RONCH.

IN THE DOLOMITE MOUNTAINS (see p. 367).

THE
GEOLOGICAL MAGAZINE.

No. CX.—AUGUST, 1873.

ORIGINAL ARTICLES.

I.—ON THE SURFACE-GEOLOGY OF THE NEIGHBOURHOOD OF CROSS FELL, IN CUMBERLAND.[1]

By C. E. DE RANCE, F.G.S.

THE eastern margin of the Vale of Eden, in the neighbourhood of Blencairn, Ousby, and Melmerby, is abruptly terminated by a steep and lofty escarpment, which rises to an eminence of 2892 feet at Cross Fell, 2331 feet at Melberby Fell, and 2082 feet at Fiends Fell, the elevations between these points being nearly as great. Eastwards, from the top of the escarpment, a large expanse of elevated moorlands slope gradually towards the North Sea.

The upper portion of the escarpment consists of successive scars of limestone and grit resting conformably on "Old Red" Sandstone and Conglomerate, lying in denuded hollows of Lower Silurian rocks, which form the base of the range, and abut against the Permian Sandstone, brought in by the Pennine fault.

In general aspect the Cross Fell escarpment may be compared to that of the North Downs near Folkestone, the Limestone scars corresponding in a scenic point of view to the Chalk (weathering in very similar curves), the Old Red and Lower Silurian to the Gault, and the Permian and Boulder-clay plain to that of the Lower Greensand.

Near Folkestone lines of springs occur at the base of the Chalk, the overflow of a wedge of water partially held back by the sea, after flowing down the dip of the strata. Springs occur on the face of the Cross Fell escarpment, above impermeable beds of shale, with a similar inwards dip, the overflow probably being caused by the outlets of the water, the lower outcrop of the water-bearing stratum not being sufficiently large for the volume of water flowing out into the streams.

The continuity of the lower escarpment of Cross Fell is broken by several valleys cut back into the breast of the hill, as Ardale, between Muska Hill and High Cap. This valley runs a mile into the hill to a height of 1750 feet, after which the stream flows over a sloping plain and through an escarpment "Black Doo," through which it has cut a V-shaped hollow.

North of this, nearer Melmerby, is an extremely wild valley,

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[1] The notes on the Cross Fell district were chiefly made during a holiday expedition into that country in July, 1872, and partly when in the adjacent country with Prof. Hull, F.R.S., in April of the same year.

Ousby Dale, excavated almost entirely in Silurian rocks, overhung, on the west, by Cuns Fell, 1760 feet high, the top of which was found by Prof. Hull and myself to be composed of Minette. This valley, the level of which is above 1250 feet, splits into several branches, or rather the stream (rising in the peat-covered plain above) divides into several runnels, which flow rapidly down the escarpment without forming a valley. Great numbers of these streams do not appear to originate in springs, but to draw their supplies from a sheet of water at the base of the peat,[1] which on the slopes is extremely wet, but becomes drier nearer the watershed, which is an extremely flat arch in section, with the water flowing below the surface as a sheet, and never differentiating into a stream, the first intimation of which appears to be at the foot of the curved slope, where the water breaks out and appears at, and on the surface, and then eroding the peat into channels, forms the first beginning of a stream.

On the south side of the Cross Fell escarpment is the Great Dale, through which flows Crowdundle Brook, which separates Cumberland from Westmoreland. At the foot of the escarpment it meanders across a narrow alluvial plain, bounded on either side by cliffs of Permian Red Sandstone and Boulder-clay.

Between the Pennine fault and the escarpment there is a terrace of Lower Silurian rocks rolling in a series of W.S.W. anticlinal and synclinal folds under the Old Red Sandstone conglomerate, which forms the conformable bed of the Limestone series. Of these beds, especially of the Skiddaw Slate, magnificent sections[2] are exposed, where Crowdundle beck has worked across its alluvial plain, and eaten back the bluff margining the terrace into cliffs, more or less covered with Boulder-beds; and at still higher elevations on Grumply Fell may be noticed many large boulders of felsitic ash and breccia, and also of Permian Sandstone, at 1300 feet above the sea by the aneroid.

Within the escarpment the Great Dale is extremely wild, the bottom scattered with irregular heaps of rounded and angular masses of rock and stones, through which the brook forces its way in two and sometimes into three changing and shifting channels. These stones are partly derived from cliffs, which are very fine, especially those on the north or Cross Fell side, which rise 500 feet in a horizontal distance of 370 yards (from 1508 to 2000 feet above the level of the sea) at Willie Bed, from which the ground slopes gradually up to the last small escarpment forming the top of Cross Fell.

Ascending the beck after leaving hard felsite, which apparently rests conformably on the Skiddaw Slates at 1149 feet, not much is seen until the Old Red Sandstone is reached, dipping into the hill rom 1250 feet to about 1400 feet above the sea, the thickness being ot less than 400 feet; the pebbles are chiefly derived from the Volcanic rocks of the Lake-district.

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[1] Every peat-covered plateau, in fact, acts precisely as an ordinary sponge filled with water; never giving off any considerable streams, save after rains, when the spongy mass is surcharged with moisture and pours into the Dales those peat-stained moorland waters which painters love so dearly to depict.—Edit. Geol. Mag.

[2] From one of these sections Prof. Nicholson obtained *Agnostus Morei*, Salt., and other rare fossils.

From the forms discovered by Dr. Nicholson in the beds of this ge, it would appear to have been deposited in very shallow water, nd at the base it often rests on old valleys, which in some cases ppear to coincide with the modern one in this direction, as Little Dale, west of Grumply Fell, in the bottom of which occurs an utlier of Old Red Conglomerate, 100 feet below the base of the ain mass. This formation cuts off the upward extension of the oints, fissures, and vertical dykes of siliceous red hæmatite so ommon in the Volcanic series under Cross Fell; but whether the iron in them, and in similar dykes in the Lake-district described by the late Mr. John Bolton, was derived by percolation from the red beds of the Old Red Sandstone above, is a doubtful point, though it is very possible that what may be called the primary or upper valleys of the Lake-district were Old Red lake-basins, from which all Red Beds have since been removed by later denudations, except in the district flanking the Lake-district, as at Butterswick, and near Ulleswater, etc., where Prof. Phillips, F.R.S., has described them.

Following Crowdundle beck to the watershed,[1] the alluvial flats disappear, the sides approach, and the valley becomes a V-shaped gorge, with cliffs gradually steeper and steeper, various limestones and sandstones dipping into the hill at about 15°, until weathered basaltic columns of the Great Whin Sill are seen standing, each separate, like a row of gigantic figures against the skyline. This magnificent sheet of basalt, measured by the aneroid, appeared to be 100 feet in thickness. Its upper surface, where cut into a little notch by the beck, was about 1840 feet above the sea. A little above occurs the Tyne-bottom Limestone, which reappears on the dip, on the other side of the Fell, many miles to the east, forming the bottom of the South Tyne. At about 2000 feet the gorge rather widens, and a small waterfall occurs over a shale bed, which is gradually being worn back under sandstone; but it again contracts, near a mine level, and becomes smaller and smaller, until it is lost in a mere runnel, in the thick peat forming the col, 400 yards on the eastern side of which the Tees takes its source in a similar runnel, at 2502 feet above the sea.

From the col, which has an elevation of 2540 feet, down to the River Tyne, the country consists of long dreary moors sloping gradually eastwards, through which the Tees has formed an extremely shallow valley, with a peat-covered alluvial plain, bounded by low cliffs, which increase in height to some sixty feet at Providence Vein, opposite the sources of the Tyne. The slope of the country is that of the beds; but the latter dip at a rather stronger angle, the lowest of the Cross Fell beds being, however, the Great Whin Sill.

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[1] In addition to the great watershed running along the Cross Fell range in a general N.N.W. direction, separating the waters that flow into the North and Irish Seas, another originates in the terraced scars of that mountain, running a little north of east, separating the valleys of the Tees and the South Tyne, passing near the source of the latter river to Bel Beaver, on which is some evidence of an old camp, from whence it turns northward to Burnhope Seat (2452), and runs along that range of hills (the boundary between Durham and Cumberland, and afterwards, further north, between the former and Northumberland), parting the waters of Weardale from those of the rivers East and West Allen.

The whole of this Upper Tees Valley would appear to be preglacial, for Boulder-clay occurs on the cliff tops well within the very head of the valley under the col. The gradual denudation of valleys by river-action is well seen in the higher course of the South Tyne, and of the Tees. Between Alston and Garrigill, strong stone walls, locally called Warrens, built in the last century to keep the river from eating away the land, are now in the centre of alluvial meadows, some distance from the river, and several feet above its level. In some places there are at least three terraces, but generally they have been swept away by the river, which constructs a fourth with a portion of their *débris*, and new spoils from above. From Garrigill, which is built on the lowest alluvial terrace, to Tynehead Smelt Mill, the river flows on the Tyne-bottom Limestone; a little north of this point the "Great Sulphur Vein" brings the Great Whin Sill to the surface, which forms a great boss, more or less glaciated, and covered on the west side of the river with dark-grey Boulder-clay, with many rounded and subangular stones, most of which are scratched, at an elevation of 1560 feet above the sea. The river has cut a narrow notch through the basalt, but not completely, for there is a small waterfall—"Tynehead Force." In the deep tributary valley of Shield Waters there is a much finer waterfall, Cashburn Force, also on the basalt; fine cliffs of columnar basalt were also found by Prof. Hull and myself near Smittergill Mine.

Above the Smelt Mill the deep glen gradually contracts the cliffs on either side, until, at the source of the Tyne, two long sweeping peat-covered slopes range upwards to the top of Bel Beaver Rigg to the east, and Noonstones to the west; the top of the former hill is said once to have been a Roman camp.

From the top of the col, above the source of the Tyne, the ground on the other side slopes gradually down to the nearest point of the River Tees, which flows past in direction nearly at right angles to the course of the Tyne. Thick deposits of dark grey Boulder-clay form the banks of Crookburn, above the Tyne-bottom Limestone, which is glaciated near its junction with the Tees. I found Boulder-clay as high as 1770 feet towards the source of the river, but none on the col between Tees and Tyne, or the still higher col between the Tees and Crowdundle beck, which runs into the Eamont, in the vale of Eden, resting on the Permian sandstone of that vale. Between Penrith and the foot of Cross Fell are sheets of Upper Boulder-clay, with an underlying sandy gravel, which in Melmerby, Ousby, Blencarn, and Skirwith, contains erratic rounded pebbles of the Lake-district, much resembling in character, as well as in that of the matrix, the Boulder-clay of Lancashire. Erratic pebbles and blocks abound on the Silurian hills at the bottom, forming the lower slopes of the Cross Fell range, and even on the lower portions of its magnificent limestone escarpments, the lowest of which, the Melmerby Scar Limestone, is 131 feet in thickness. The escarpment runs along the strike of the beds, but here and there they have been cut back, and deep openings and narrow valleys break the uniformity, and well show the inward dip, even at a distance. This was particularly the case when I first saw this range, at the end of April, when the escarpments were picked out with snow, which lingered on in crevices until nearly June.

II.—NOTES ON THE EXTENSION OF THE BOULDER-CLAY OVER THE GREAT AND LITTLE ORME, AND THE CEMENTING TOGETHER BY LIME OF SOME LARGE BOULDERS IN THE CLAY NEAR THE LITTLE ORME.

By W. C. LUCY, F.G.S.

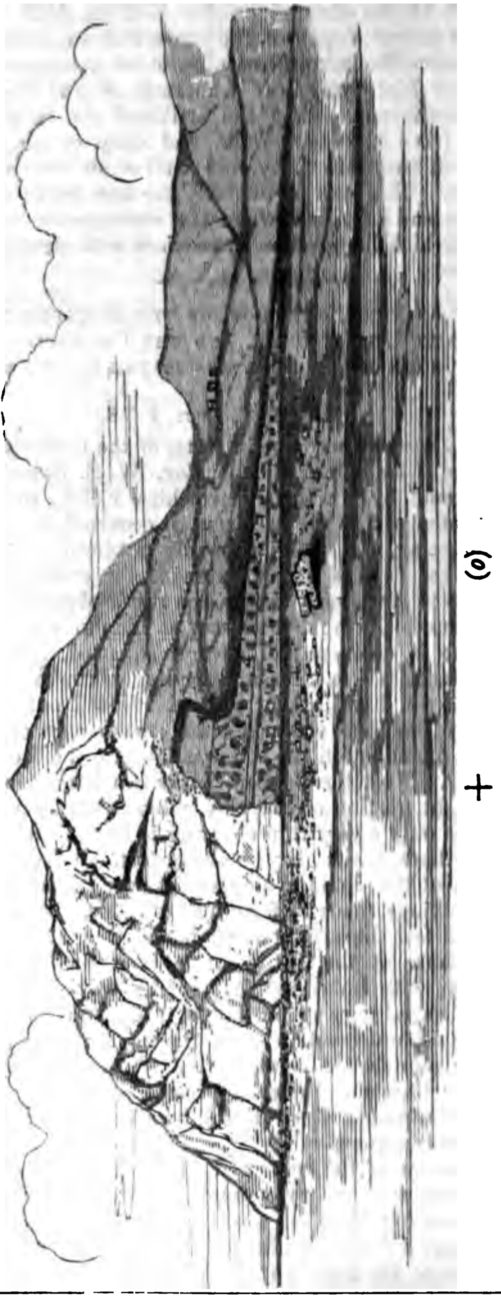
HAVING seen an account, in Notes of the Geology of the District round Llandudno, by the Rev. W. S. Symonds, that shells had been found by Mr. R. D. Darbishire, F.G.S., in some clay near the New Baths at the Great Orme, it occurred to me that the clay was Boulder-clay, and would probably not be limited to so small a patch, but that it most likely extended far over the hills. And I now propose to give, very briefly, the result of some observations on the subject made during a short stay at Llandudno.

The Orme is composed of several squatted, rounded masses of Carboniferous Limestone, resembling huge farmhouse loaves, which give form to small valleys or gullies. Now I noticed that in these valleys or gullies there was vegetation; some corn crops were growing, and on examination the soil was found to be the remains of the Boulder-clay. Near the Copper Works is a large boulder of several hundredweight, resting on the clay, which is traceable over the hill, but in places only a very thin covering is left. The highest rounded portions are bare, which may be owing to there having been no place for it to rest at the time the clay swept over the hill.

In the cuttings made in forming the roads, good sections of drift occur several feet thick, containing boulders of large size.

On the shore at the Little Orme is a fine exposition of the Boulder-clay, with imbedded drift, as shown in the accompanying sketch. It varies very much, but at the point marked + the following is an accurate section:—On the surface is about a foot of soil, resting upon four feet of Boulder-clay, followed by eight to ten feet of angular drift, some blocks of great bulk and cemented together by lime, and reposing upon ten to twelve feet of drift of smaller size only partly cemented.

Several masses of the cemented drift were lying upon the beach, and the largest two are represented by the following drawings:—Fig. 1 shows a big block of smooth limestone with a face of about 5 ft. 6 in. long, 4 ft. 6 in. wide, and 5 ft. thick, to which was attached a huge mass of the drift 7 ft. long by 4½ ft. thick, containing large



Sketch of the Little Orme from the shore, with section of Boulder-clay exposed at (+), and masses of cemented blocks lying on the beach at (o).

angular boulders with some small pebbles in a clayey matrix, all cemented together by lime, which formed a septa or division presenting a singular appearance.

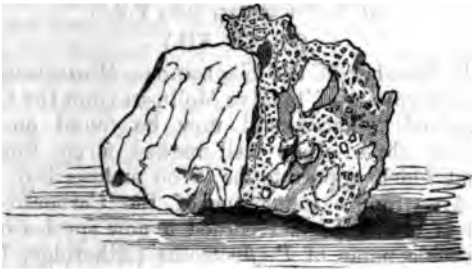


Fig. 1. Mass of smooth limestone, from the shore at the Little Orme, cemented together with angular boulders and small pebbles in a clayey matrix.

Fig. 2 represents a large mass of irregular form, being 15 ft. across the top and fully 7 ft. thick. It is cemented in like manner to Fig. 1, and so firmly is it held together that it is difficult to knock out a piece with the hammer. On one side it will be seen there is an opening running into the centre about 3 ft.

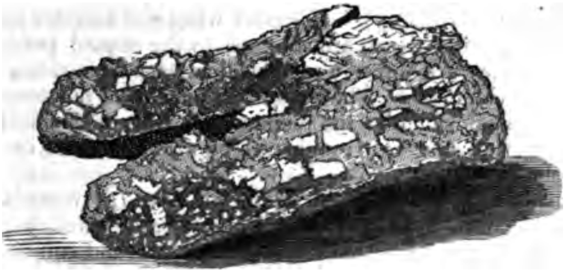


Fig. 2. Large mass of breccia, similar in character to Fig. 1, lying on the beach at (*o*). See sketch of Little Orme.

The large blocks are mainly of Carboniferous Limestone, but in the mass are Basalt, Syenite, Quartzite, Granite, Felspathic Porphyry, Greenstone, rolled Slate, Trap, etc.

As the whole of the lime which passed through the surface soil and cemented these large masses together must have been derived from the infiltration of rain-water, acting upon and dissolving the limestone of the Little Orme, and as this occurred subsequently to the deposition of the Boulder-clay, a considerable time must have elapsed to form these conglomeratic masses of cemented detritus.

A careful mapping of the two headlands, showing the remnants of Boulder-clay and drift, would be of much service to amateur geologists of glacial phenomena like myself, when visiting this district, and I trust the same will be undertaken by some one of our Professors of Geology this Autumn season.

III.—CONTRIBUTIONS TO CARBONIFEROUS PALÆONTOLOGY.

ON SOME FURTHER UNDESCRIBED SPECIES OF *LAMELLIBRANCHIATA* FROM THE CARBONIFEROUS SERIES OF SCOTLAND.

By R. ETHERIDGE, Jun., F.G.S.

(PLATE XII.)

IN the July Number of the GEOLOGICAL MAGAZINE, I described certain new species of bivalve Mollusca from the Carboniferous series of Scotland. These will now be found on Plate XII., accompanied by three other well-marked forms from the same formation, and which appear to me to be undescribed. In Messrs. Young and Armstrong's Catalogue of the Carboniferous Fossils of the West of Scotland[1] is recorded a new species of *Pteronites*, under the specific name of *P. fluctuosus* (Etheridge, MS.), a shell so named by my father, but never yet described. *P. fluctuosus* is specifically remarkable for its small size, and the absence of ribs on the anterior side. The disposition and arrangement of the shell ornamentation affords a good means of specific identification in several of the Carboniferous species of *Pteronites*, as the following synopsis will indicate:—

Pteronites persulcatus, (McCoy).[2] Shell large, with the surface covered with coarse, rugged, flexuous, irregular, slightly interrupted ridges.

P. semisulcatus (McCoy).[3] Posterior wing and anterior side of the shell devoid of ribs, which are confined to the central portion of the shell, where they are obtusely rounded, and vary from seven to eight.

P. sulcatus (McCoy).[4] The wing and a portion of the posterior end in this species are smooth; the remaining portion of the shell, including the anterior side, is "roughened by about thirteen or fourteen rugged obtuse ribs."

P. regularis (R. Etheridge).[5] Here we have, as regards general outline and form, a repetition of *P. persulcatus* (McCoy), but the shell is smaller, and the ribs are even, flexuous, and equidistant, not rugged or broken up.

Such is the variation in ribbing amongst the larger species of Carboniferous *Pteronites;* and if we now add the same characters of the species about to be described, *P. fluctuosus*, the gradual gradation and variation in surface ornamentation will be apparent. In this species the wing and posterior end, instead of being plain, as in *P. sulcatus*, are covered with ribs, whilst the anterior side is devoid of such.

Three other species of *Pteronites* are found in British Carboniferous rocks, but as two of them are smooth, and the form of the third is sufficient to distinguish it, they need not be here taken into account.

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[1] J. Young and J. Armstrong, "On the Carboniferous Fossils of the West of Scotland," Trans. Geol. Soc. Glasgow, vol. iii., 1871.

[2] McCoy, Brit. Pal. Fos. p. 480, pl. 3 F. fig. 1.

[3] McCoy, Synopsis Carb. Fos. p. 81, pl. 11, fig. 32.

[4] McCoy, Synopsis Carb. Fos. p. 82, pl. 13, fig. 5.

[5] R. Etheridge, GEOL. MAG. July, 1873, p. 298.

'hey are *P. angustatus*[1] (McCoy); *P. latus*[2] (McCoy); and *P. ventri-osus*[3] (McCoy).

Pteronites fluctuosus unites, in the disposition of its shell ornamen-ation, McCoy's two species, *P. semisulcatus* and *P. sulcatus*. It grees with the first-named in the comparative smoothness of the nterior side, but departs from it in the possession of ribs on the osterior side and wing, which likewise distinguishes it from the ast named, in addition to the anterior ribs of that species. The pecific diagnosis of *P. fluctuosus* is as follows :—

Pteronites fluctuosus, sp. nov., Pl. XII., Fig. 1.

'. *fluctuosus* (Etheridge, MS.), J. Young and J. Armstrong's Cat. Carb. Foss. W. Scotland, Trans. Geol. Soc. Glasgow, vol. iii., 1871, p. 48. (*Without description.*)

Specific char.—Transversely trigonal, slightly gibbous; anterior ide rounded; posterior end broad, somewhat sigmoidal; posterior ring rather large, thin, pointed, and, as indicated by the lines of rowth, reaching quite as far as the posterior side; hinge-line traight, well pronounced; postero-ventral margin convex; antero-entral margin concave; beaks large, convex, nearly terminal; urface characteristically ornamented; the posterior wing is marked rith equidistant, straight, strong, radiating ribs; on the body of the hell these become depressed. broad, and flexuous, passing down owards the ventral margin; beaks and anterior end of the shell are omparatively plain, with the exception of a few lines of growth; ines of growth generally well marked, about five or six, distinctly ndicating the pointed nature of the wing. This shell is usually ound with the wing somewhat broken, as shown in the figure, re-ulting probably from the delicacy of the shell.

Localities.—Shale of the Lower Limestone Series, Craigenglen ampsie. Discovered by Mr. J. Young, who has presented specimens o the Museum of Practical Geology, London.

One of the more interesting groups of shells found in Carboniferous ocks is that of the *Aviculopectinidæ*. Making its first appearance in trata of Devonian age, *Aviculopecten* rapidly increased in specific mportance until in the succeeding Carboniferous the genus attained ts greatest development. From beds of this age in the British Islands lone no less than about ninety-four species have been described. t is, however, more than probable that many of these so-called pecies are only the corresponding valves of forms described under nother specific name. In his "British Palæozoic Fossils," McCoy emarks that although the generality of the shells originally referred o *Pecten* in Palæozoic rocks would fall into his *Aviculopecten*, still, his would not altogether preclude the occurrence of *Pecten*, and in upport of his argument cited a few species which he considered bore ut his views. In addition to those mentioned by McCoy, I have vidence to show that several more of our Carboniferous Pectinoid hells possess the characteristic central cartilage-pit in the hinge, and would therefore remain in the genus *Pecten*, as originally placed by their respective describers, rather than *Aviculopecten*, as all such shells have been termed since McCoy first described the latter genus. This I hope to make the subject of a future communication.

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[1] McCoy. l.c. p. 81, pl. 13, f. 6. [2] *Ibid.* pl. 13, f. 7. [3] *Ibid.* pl. 13, f. 8.

An exceedingly graceful species of *Aviculopecten*, which I had previously laid aside as different from any described form I could meet with, has lately come under my notice in considerable quantities from certain of the Lanarkshire Carboniferous beds. I propose to call this

Aviculopecten ornatus, sp. nov., Pl. XII., Fig. 2.

Sp. chars.—Longitudinally obovate, slightly convex, flattening towards the margin, slightly inequilateral; ears very unequal; anterior small, triangular, divided from the body of the shell, and ornamented with strong radiating ridges, which are crossed by fine delicate striæ; posterior ear large, rectangular, but in perfect specimens pointed, as shown by the curving of the lines of growth; hinge-line a little less than the width of the shell; shell thin; ornamentation very characteristic, concentrically marked with exceedingly close lines of growth, which on the anterior side only are crossed by very delicate and flexuous radiating striæ, close together. Both valves appear to be alike.

With the exception of the small anterior ear, *A. ornatus* resembles to a certain extent *A.* (*Meleagrina*) *rigida*,[1] McCoy, in general outline, but differs in numerous minutiæ, and forms one of a somewhat large series of thin-shelled *Aviculopectens*, common in Scotch Carboniferous rocks, more numerous in individuals than species, comprising such as *A. subelongatus*, McCoy, *A.* (*Pecten?*) *deornatus*, Phil., *Pecten* (*Amusium*) *Sowerbii*, McCoy, and a few others.

Locality.—Kinghorn, near Burntisland, Fife; in shale of the Lower Limestone Series. Cabinet of Mr. D. J. Brown, Edinburgh. Also found by the Geological Survey collectors at many localities in Lanarkshire (see forthcoming Explanation to Sheet 23, Geol. Survey of Scotland).

An equally interesting series of shells, although not nearly so numerous in the matter of species, yet quite so as regards individuals, are the Carboniferous *Nuculidæ*, comprising the genera *Nucula* and *Leda*. By the late Mr. J. W. Salter, the greater portion of the Palæozoic species of these genera were merged in his *Ctenodonta*,[2] a genus originally instituted for the reception of certain North American species of *Arca*,[3] *Nucula*, etc. Salter's *Ctenodonta* possesses an external ligament and hinge teeth, but no central cartilage-pit, and, so far as Silurian species are concerned, is a good genus; but I think that many of the Carboniferous *Nuculæ* and *Ledæ* referred by that lamented palæontologist to *Ctenodonta*,[4] were so placed hastily, and without sufficient consideration. I have examined a very large number of these little shells, both from English and

[1] McCoy, l.c., p. 80, pl. 13, f. 16.

[2] Geol. Surv. Canada, Decade 1, p. 34.—Mems. Geol. Survey, vol. 3, app. p. 345.

[3] Brit. Ass. Rpt. 1851, Trans. Sect. p. 63.

[4] Mems. Geol. Survey, Country around Oldham, Sheet 88 S.W., p. 65.

Scotch Carboniferous beds, and have never yet succeeded in finding any trace of an external ligament; but, on the contrary, in a few well-preserved interiors of the type species of *Nucula*, *N. gibbosa*, Fleming (*N. tumida*, Phil.), I have distinctly seen the cartilage-pit.

As one of those intermediate forms which in external characters unite the genera *Leda* and *Nucula*, the following undescribed species is of some interest. I have as yet only noted it from Scotch localities, and, although abundant as regards individuals, is one of the less common species.

Leda intermedia, sp. nov., Pl. XII., Fig. 3.

Sp. chars.—Shell transversly elongate; valves compressed and flattened, least so below the beaks; anterior side rounded; posterior side compressed, narrower than the anterior, with a blunt rounded termination; beaks nearly central, contiguous, depressed; dorsal outline slightly convex on the anterior side, concave and inclined downwards on the posterior side; ventral margin convex, most so on the anterior side, inclined upwards on the posterior side; surface with very close regular concentric striæ.

This is a well-marked shell, easily distinguishable from an allied form, *L. attenuata*, Fleming, by its very compressed valves, much shorter posterior side, and the almost median position of the beaks, Of all the published descriptions of Carboniferous *Ledæ* within my reach, *L. intermedia* approaches nearest to *L.* (*Yoldia ?*) *lævistriata*, Meek and Worthen, from the upper part of the St. Louis Group of the Carboniferous Limestone Series of Illinois.[1]

Locality.—Orchard Quarry, about four miles south of Glasgow, in the shale of the Orchard Cement Stone (Upper Limestone Series). *Leda intermedia* ranges from the Wardie Shales (Calciferous Sandstone Series) to the Upper Limestone Series. I have lately detected it in the latter at Spy Mill, Water of Leith, near Edinburgh.

EXPLANATION OF PLATE XII.[2]

FIG. 1.—*Pteronites fluctuosus*, Etheridge, from shale below the Main Limestone (Lower Limestone Series), Cleckhimin Quarry, S.E. of Carluke. Collection of the Geological Survey of Scotland. × 2½.

FIG. 2.—*Aviculopecten ornatus*, R. Etheridge, from shale of the Lower Limestone Series, Kinghorn, Fife. Natural size. Cabinet of Mr. D. J. Brown, Edinburgh.

FIG. 3.—*Leda intermedia*, R. Etheridge, from shale of the Orchard Cement Stone, Orchard Quarry, near Glasgow. × 2.

FIG. 4.—Portion of shell of another specimen, showing the close fine concentric striæ.

FIG. 5.—*Conocardium decussatum*, R. Etheridge, from the shale of the Orchard Cement Stone.

FIG. 6.—*Pteronites regularis*. R. Etheridge, from shale of the Upper Limestone Series, Linn Spout, Dalry, Ayrshire. Cabinet of Mr. J. Young, Glasgow.

FIG. 7.—*Myacites ?* (*Allorisma*) *tenuilineata*, R. Etheridge, from Lower Limestone Series at Cousland, near Edinburgh. Cabinet of Mr. D. J. Brown, Edinburgh.

[1] Pall. Ill. vol. 2, p. 282, pl. 20, f. 7.

[2] In consequence of the serious illness of the artist, Mr. C. L. Griesbach, this Plate is unavoidably postponed until the September Number.—EDIT. GEOL. MAG.

IV.—ON THE CARBONIFEROUS DEPOSIT OF THE BROWN CLEE HILL AND ITS RELATION TO CONTIGUOUS COAL-FIELDS.

By D. JONES, F.G.S.

THE Coal-measures of the Brown Clee are of themselves extremely insignificant and unimportant. The total area is limited, and the thickness of the coals would not have entitled them to be considered of commercial value, if it were not for the fact, that from its elevated position it is placed well above the reach of water, and hence the great difficulties which beset early mining operations in freeing the mines from water did not affect the coal-mines of the Brown Clee; consequently, in those times they were worked to advantage, but there is very little coal remaining to be won. They have, however, a value to the geologist, as indicative of the much wider range of the Coalbrookdale Coal-measures than is shown by its present boundary, for there is an unmistakable analogy between both deposits, to which we shall presently refer.[1]

We are now at an elevation of 1730 feet above the level of the sea, upon the summit of a hill, which is surmounted with a capping of Jew-stone, and beneath it a patch of Coal-measures not exceeding a total thickness of 110 feet. Beneath that we have Millstone Grit, which, it has been stated, is 200 feet thick, but in my opinion is considerably less, and the Geological Survey have omitted to show that there is any whatever.

Below that we get the whole base of the hill, consisting of Old Red Sandstone. This capping of Coal-measures is divided into two patches, occupying the two points of the hill known as Clee Burf and Abdon Burf.

The presence of the Jew-stone, which is an igneous rock, at once gives us a clue to the cause of the singular elevation of these coal patches; and not only so, but explains to us how they have escaped the denudation which has overtaken a very large area of Coal-measures that once laid in a sheet around this site, the Jew-stone having acted from its hard and obdurate nature as a protector and breakwater against the incursion of the denuding waves.

Immediately below this igneous rock we have a coal which is called the "Jew-stone Black Coal," which, with the intervening partings, measures about 4 feet. At 13 feet below this is found the Three-quarter Coal, measuring 2ft. 3in., and I should not forget to mention that between these two coals is a substance called by the miners "Black Bessy's Eyes," no doubt in honour of some belle in the miners' village long ago.

Beneath the Three-quarter Coal, at a distance of 7ft. 9in., lies the "Batty Coal," which, with coal and partings, measures 5ft. 3in. At 63 feet below this we find the "Bottom Coal," 2ft. 4in. thick, which sometimes rests upon the Millstone Grit, but more frequently has a few feet of Coal-measure intervening.

Not far above the Bottom Coal lies the Ironstone, which was merly worked to a considerable extent, and carried into Bewdley rest for the purpose of smelting.

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[1] Further details relating to these Coal-measures are given in a paper by Mr. D. Jones, published in the GEOL. MAG., Vol. VIII. p. 200.

On a careful comparison of this section with that of the Cornbrook strict, it appears there is an unmistakable identity, and these coals resent those of Cornbrook, ranging from the "Great Coal" to "Four Feet Coal," but there is this remarkable difference in rest of the deposits, that whereas the Bottom Coal of the Brown e (which is equivalent to the Four Feet Coal of Cornbrook) ts upon the Millstone Grit, we have at Cornbrook a thickness of 4 feet of Coal-measures below the Four Feet Coal, followed by "Gutter Coal," and other measures, making a total of 454 feet ween the Four Feet Coal and the Millstone Grit. The Millstone it is between 200 and 300 feet thick at Cornbrook, whereas at Brown Clee it cannot exceed 50 feet at the most. The points nearest contact between Cornbrook and Brown Clee Hill are out three miles and a half apart, and it is a most remarkable ng that such a difference should exist with regard to the lower posits.

I may remark that at Harcott there is another patch of coals ich correspond with those of Cornbrook and Brown Clee; but in t instance the coals rest immediately upon Old Red Sandstone, thout any intervening Millstone Grit. How then does it happen t at Harcott and Brown Clee we have little or no Coal-measures derlying the equivalent of the Four Feet Coal, whereas we have great a thickness at Cornbrook? It seems to me that subsequent the deposition of the Millstone Grit it was upheaved in the ality of Brown Clee and Harcott; it was then partially denuded the Brown Clee, but at Harcott entirely denuded. In the low ound at Cornbrook, the "Gutter Coal" and Coal-measures underng the Four Feet Coal were accumulated, and then the Four Feet al was formed, this accumulation of Coal-measures raising the el of the Four Feet Coal sufficiently high to allow it to range er the elevated ground which we have referred to at Harcott and own Clee.

I can see no other interpretation of this phenomenon, unless it ld be shown that the Harcott and Brown Clee Coals are the uivalents of the "Gutter Coal" of Cornbrook, but a careful comrison of the sections shows distinctly that they are not; on the ntrary, they all answer to the series lying between the Great al and the Four Feet Coal of Cornbrook.

It is very interesting to trace the connexion of these patches, cause it tends to elucidate phenomena which present themselves the Coalbrookdale fields, where a vast washing away of coal ata has taken place, and has produced what is locally known as e Symon Fault. It has also washed off much of the deposits uth of a line drawn from Ketley to Lilleshall.

To a person travelling through Shropshire, and passing over the al-measures which may be seen distributed over several parts of e county, it might seem an extremely rich and productive coal strict; but he would be grievously deceived if he placed the district of Bewdley Forest in the list of productive coal-fields. That it once was the site of a rich and productive coal-field there can be no doubt, and this is testified by the remnant of productive Coal-measures found at Harcott; but the main original deposit has been removed by denudation, with the exception of that remnant and the patches at Brown Clee and Cornbrook. The void was subsequently filled up with Upper Coal-measures of the unproductive character which we know to exist in the Bewdley district.

Seeing that the Millstone Grit thickens to the south-west, as at Cornbrook, and also the older Coal-measures, one is inclined to believe that in this direction we are passing from the high ground which forms the base of the Coal-measures at Coalbrookdale and in South Staffordshire into lower ground capable of receiving the Millstone Grit and a greater thickness of Coal-measures; and this being so, is very suggestive of the probable connexion at an earlier period of these coal-fields with those further, south, as, for instance, the Forest of Dean, where the deposits are of a similar character.

In the neighbourhood of Cornbrook there are still considerable quantities of coal remaining unwrought, and previous to the extension of railway communication it was a blessing of the highest importance to the district that this Coal-field had escaped denudation.

It may seem, perhaps, surprising that the greater portion of the Cornbrook Coal-field is covered with Jew-stone, in some cases 150 feet thick, which has been poured out over the Coal-measures, and so protected them from denudation. This igneous rock is of considerable value as a paving-stone, and the nature of the Jew-stone at Brown Clee and Cornbrook seems to be precisely the same. They were probably contemporaneous ejections. I do not think it probable that they were injected between the strata of the Coal-measures in the same way as we find in South Staffordshire, where sheets of Basalt take the place of acres of coal. The Titterstone Clee is itself an ancient volcano, and probably was active at the time the Jew-stone was spread over the Coal-measures.

Believing, as I do, that all these patches of older Coal-measures were once connected, and formed part and parcel of the Coalbrookdale and South Staffordshire Coal-fields, I think there can be little doubt that the Coal-measures of Cornbrook and Brown Clee were at one time of infinitely greater thickness; but previous to the deposit of the Jew-stone they must have been considerably denuded, because, so far as we can co-relate the Cornbrook deposits with those of Coalbrookdale, they are not more than half their thickness, so that the history of events which we have passed before us in review points to an uneven surface, upon which the Millstone Grit was deposited; changes of level and denudation at that time, subsequently the deposition of Coal-measures and their accumulation, until the whole of the productive Coal-measures of Coalbrookdale and South Staffordshire were formed—and afterwards a vast denudation over the districts we are speaking of, which removed the greater part of this deposit, leaving only here and there islands to testify that they once had been. Then follows the deposit of the

Upper Coal-measures in these denuded hollows, first filling them up, then covering such islands of older Coal-measures as might remain.

These statements may appear startling to those who have not made a study of the subject; but I can assure them that if they will mentally peel off the Upper Coal-measures, they will find beneath the vacuities produced by this denudation, and such islands of older Coal-measures as may have been left. They will find that they have exposed to view an ancient valley, and the gradually sloping side of the Coalbrookdale Coal-measures thickening as they retreat from the influence of the waters.

Still further, if they will peel off the Old Coal-measures, they will find a surface where the hollows have been filled up with Millstone Grit, leaving higher ground of Silurian rock, and it is only by dealing with the subject in this way that one can realize to one's self the events which must have taken place. These truths, nevertheless, are far less astounding than those which are unfolded to us by other sciences, and furthermore they are not statements which are invented to amuse, but they are truths upon which great commercial undertakings in mining are based.

V.—On Changes of Climate and Extinction of Mammalia.[1]

By Alex. Anderson, Esq., J.P., Victoria, Vancouver.

It has been argued by some that the seas were anciently cooler than at the present day, and that thence certain ulterior effects might be assumed. Without treating of the supposed effects, I wish to state that the premiss itself seems to me inconsistent with what, geologically viewed, appears to be the order of transition through which our planet has passed in its successive changes. My own unprofessional view, founded upon grounds generally admitted, has been that, from a temperature originally much higher, the oceans had gradually cooled down under adequate influences to the mean temperatures which they now maintain under the permanent climatic conditions of the globe; and indeed that the peculiar condition distinguished by geologists as the "Glacial Period" was but the effect of the rapid condensation of the vapours arising during the long-continued process of cooling, under a great and sudden organic change. I will not, however, dwell on this point, lest I should seem but to iterate arguments that have already proceeded from other sources.[2] Nevertheless, I venture further into the consideration of abstruse points connected therewith, in vindication of the position I have advanced, in my notes on the improbability of the coexistence of the Reindeer and ancient Hippopotamus, communicated to the "Reliquiæ Aquitanicæ."

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[1] Communicated to Prof. Rupert Jones, F.R.S., in a letter dated December 10th, 1870.

[2] I make this remark because I met with a brief notice in the scientific columns of the *London Illustrated News* of August 13th, 1864, from which I learn that Prof. Frankland, in a then recent lecture, had enunciated views on this subject almost coincident with my own: and also that Prof. De la Rive, of Geneva, had promulgated a similar opinion as far back as 1852. That I feel flattered by the support which my modestly conceived opinion receives incidentally from these high authorities, I need not add; and also that I am thereby rendered the less diffident in its expression.

Under no ordinary hypothesis do I conceive—nor is my opinion, I believe, unsupported—that the great terrestrial changes revealed by the observations of the geologist can be accounted for. Causes immeasurably more potent than the processes of Nature as at present observable, under any modification that the imagination can realize, must have contributed to produce the stupendous results that are apparent. Short of successive inclinations of the earth's axis to greater degrees at various epochs, I conceive of no adequate agency: but, this agency admitted, much that is otherwise mysterious would, I opine, be satisfactorily solveable. Physically viewed, the agencies to this great end are at least within the scope of the imagination, under those universal laws of gravitation acting on a spheroidal mass, exemplified even now in the slight periodical nutation of the pole under the varying counter-attractions of the sun and moon. Were it permitted to suppose that our planet was at one period attended, like Jupiter, by several satellites, it would have been retained by the counterpoise of attraction in a vertical position with regard to its orbit, as may be mathematically demonstrable, even as Jupiter is so now retained—and consequently have revolved in its annual course without appreciable seasonal variation. The successive destruction, at various epochs, of these imagined satellites would have produced proportional deflections of the axis with corresponding variation of season and climate; the last, that condition under which Man was created and exists. Astronomy teaches us that planetary catastrophes, such as here supposed, are not only within the limit of possibility, but have actually occurred. It has been suggested even that the meteoric stones, of which the frequent fall has been enigmatical, are but the scattered fragments of anciently disrupted spheres revolving in space until casually coming within the earth's attraction. May it not then be permissible, if the theory I have hazarded be not summarily rejected, to suppose that some, at least, of these mysterious visitors may be but the scattered relics of vanished satellites of our own planet? Step by step the geologist, instructed by gradually developed indications, approaches conclusions of which the principles only are shadowed forth in the revealed account of the cosmogony, but to which, reverentially accepted, they nowhere stand in opposition. The history of the science has well been termed "a growing evidence." Yet in its revelations, while much may be demonstrated by comparison with palpable types, much again must be inferential, from the collation of circumstances with the undeviating processes of known natural laws.

Under the assumption I have advanced, the formation of Coal, originating from a vegetation consistent only with a climate analogous to the inter-tropical climates of to-day, and irreconcilable with the variations incident to the temperate zones, may have proceeded far beyond the limits where that fossil fuel is now known chiefly to exist. It might be predicated, indeed, that Coal-fields exist even within the bounds of the Polar Circle. To subsequent deflections of the axis various observed phenomena may consistently be ascribed; and it is as a sequence to the latest convulsion, and pending the resulting disturbance, that the enormous evaporation and condensation of the Glacial Period may be conceived to have proceeded.[1] I do not profess to enter upon the physical minutiæ of this stupendous process; leaving that to the imagination in view of obvious natural laws. Immediately antecedent, however, to this latest convulsion, I assume to have existed the class of extinct Mammalia typified by the woolly Elephant and Rhinoceros of the north, and the ancient Hippopotamus of what are now the temperate zones:[2] by this convulsion I infer they were destroyed.

The grounds for this inference, as I shall endeavour to show, do not exist entirely in the imagination. The condition of the two well-authenticated specimens of the first-named animals revealed to view in recent times, ice-preserved, in the wilds of Siberia, presents to our consideration several points of indisputable cogency.

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[1] The disturbance here alluded to may be subject to the following explanation. Under an established law of Mechanics the sudden change of the balance of gravitation supposed must necessarily have been attended with a corresponding nutation in the vertical plane, comparatively like the oscillation of a pendulum, or the vibrations of the magnetic needle when accidentally deflected. The first effect hence arising would have been to produce an abnormal declination; in other words, to extend temporarily the limits of the polar zones far beyond their permanent confines: the converse effect, upon reaction, to contract them for a time proportionably, though to a less extent. Hence two extremes of climate, both abnormal, must be conceived to have resulted during an indefinite interval. Successive alternations, each gradually decreasing in intensity, would have followed, until the globe at length subsided under the gravitating force into that state of permanency which it has since retained. The imagination is lost while contemplating either the extent or the duration of the mechanical process thus theoretically assumed. From the vast inertia, however, of the disturbed mass suspended in space and subject to no retarding influence beyond that of gravitating attraction, it seems obvious that the effect must have been both great and long continued: and specially that the extremes of climate, occurring at the reverting points, must have been greatly protracted. This view admitted, it follows that the condensation of the vapours arising from the cooling oceans must have been immeasurably great. A condition of the globe may be conceived of under which, shrouded in mist impenetrable by the solar rays, the formation of snow must incessantly have proceeded. On the contrary, at the opposite point, under a temperature alike extreme, vast floods must have resulted from the melting snows: again succeeded by a reversed condition, producing ice. Thus alternately the process would have continued, each successive revolution lessening in degree, until ultimately the shaken sphere subsided into that normal condition of repose which it has since retained.

The floods thus generated upon the polar confines, in their progress towards the equatorial regions would not, it may be inferred, have assumed a course continuing due south, but deflecting gradually to the westward, in obedience to the same physical law by which the course of the trade-winds is regulated; a result, at least with regard to the Northern Hemisphere, in accordance, I believe, with the course of the ice-drift observed both in Europe and America in those positions where local obstacles have not casually diverted it. By the agency of these floods, in addition to the ice-contained fragments of rocks with the remains of extinct races of animals, the timber, leaves, and other vegetable matter, the produce apparently of the far north in the antecedent condition of the globe, have likewise been transported. These, as shown by the observations of Mr. Charles Whittlesey, are discovered in America imbedded deeply in the diluvial drift.*

[2] See Notes on the former existence of the Hippopotamus in Europe, by Mr. Anderson, in the "Reliquiæ Aquitanicæ," Parts XI. and XII.—EDITOR.

* Prof. Henry's *résumé* of Mr. Charles Whittlesey's Notes on the Glacial Drift of the North-Western States. Transactions of Smithsonian Institute, 1866, page 35.

1st. That the destruction was sudden, apparently simultaneous, and succeeded immediately by conditions of climate under which the process of decay was arrested.

2nd. That these conditions of climate were continuous for a lengthened period, as proved by the great accumulation of ice in which the remains had been imbedded.

3rd. That the region inhabited by these animals presented during their existence a climate subject to the variations now proper to the temperate zones,—a condition incompatible with the present declination of the terrestrial axis.

4th. That the period of their destruction was presumptively at mid-winter of the northern hemisphere; certainly between the months of September and April of our present calendar.[1]

On the other hand, the constant supply of fossil ivory[2] found within the arctic limits, liberated from time to time we must presume from the icy store-houses around, proves that the race producing it must have been numerous, and occupied widely the zone which now presents an aspect so different from that under which these animals must have existed. As a corollary to this ancient condition of what is now the frigid zone, a corresponding disparity of climate must be admitted for the temperate regions of to-day, consistent with the former existence there of the extinct Hippopotamus, and of other animals, the types of modern species confined to intertropical climates under the present unvarying conditions of our planet.

VI.—ON THE NOMENCLATURE OF SCHISTOSE ROCKS.

By G. H. KINAHAN, M.R.I.A., etc.,
of the Geological Survey of the United Kingdom.

THE term Quartzyte has been used to designate quartz-schist and seems to be generally adopted, while Argillyte is used by some authorities in place of argillous or argillaceous-schist. I would therefore suggest that the other subgroups and varieties of schistose rocks ld be given similar names. Under such a nomenclature the sts might be called as follows ;—

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[1] The analogy between the conditions of the existing Bison of North America and that of the extinct animals is striking; the inference follows in regard to the climatic and seasonal circumstances. Subjected to extremes of heat and cold in its natural habitat, the Bison is endowed by Nature with a provision conformable to both. During winter a thick coating of fine wool underlies its shaggy covering of hair; precisely as in the cases cited in the text. As summer approaches, this wintry garment gradually falls off, and is succeeded by a thin coating of new hair, corresponding for the time with that of the Buffalo of Asia and Africa, to which, as to the modern Elephant and Rhinoceros, a warmer covering is at no time necessary.

[2] Upwards of 600 mammoth tusks were last week offered for sale at the Ivory Warehouse, London Docks. Some of these were from nine to ten feet in length, and presented the peculiar double curve so characteristic of the tusks of *E. primigenius* wherever met with. See GEOL. MAG., 1868, Vol. V. p. 540, Plates XXII. and XXIII. —EDIT. GEOL. MAG.

lyte	Argillous-schist	*Micasyte*	Mica-schist
tolityte	Chiastolite-schist	*Hornblendyte*	Hornblende-schist
ityte	Phyllite-schist	*Actinolityte*	Actinolite-schist
nyte	Carbonaceous-schist	*Chloritÿte*	Chlorite-schist
yte	Alum-schist	*Talcyte*	Talc-schist
te	Calcareous-schist	*Garnetyte*	Garnet-schist
sityte	Dolomitic-schist	*Shorlyte*	Tourmaline-schist
tzyte	Quartz-schist	*Rhætizityte*	Magnesia-schist
lumyte	Flexible quartzyte	*Hematityte*	Mico-iron-schist
ryte	Ferruginous quartzyte	*Pyrityte*	Pyrite-schist
yte	Felsite-schist	*Pyrrhotityte*	Pyrite-schist

this list has been retained such old terms as Spilyte, Itacolu-e, and Itabiryte, as they are already in use.

—NOTES AND QUERIES ON THE CLASSIFICATION AND NOMENCLATURE OF THE ENGLISH STRATA.

(Communicated by W. S. M.)

(*Continued from page* 115.)

eviations.—A. *a.*—Recognized as a separate formation with definite limits, by
b.—In the year
c.—Where published
d.—Under the name
e.—Origin of the name
B.—Changes in previous grouping or name.
C.—Subsequent changes.

ER GREENSAND. A. (*a*) Fitton. (*b*) 1824. (*c*) Ann. Phil. vol. viii. n.s., p. 371. (*d*) Greensand. (*e*) Retained the title *green* sand because it had "been adopted so very generally by the geologists of England," but protested that the term was "objectionable, as being derived from a character which is not only very variable, but in reality does not belong to the greater part of this stratum." [Query—When was "Lower" added to the name ?]

B. See suprà p. 114.

C. "Neocomian" was first used as a name for the Lower Greensand of England by Dr. Fitton in his paper on Atherfield, Jan. 1845. Journ. Geol. Soc., vol. ii., p. 55.

The subdivisions "Folkestone beds," "Sandgate-beds," "Hythe-beds" (Kentish-rag), and "Atherfield Clay" were first recognized by the Survey, after the work of Messrs. Drew and Foster in 1863. The first three of these groups were recognized by Dr. Fitton in his paper on the "Strata below the Chalk," 1827, Geol. Trans., ser. 2, vol. iv. p. 115, but they were not named. The names are those of the places where the formations are best seen.

LD CLAY. A. (*a*) Fitton. (*b*) 1824. (*c*) Ann. Phil., vol. viii., n.s., p. 373. (*d*) Clay (of the Wealds and Tetsworth), at p. 369, and Weald Clay, p. 373. (*e*) Conybeare and Phillips

(1822), p. 120, **used the term Weald Clay, confounding with** it the Galt.

B. **Smith had confounded this with Kimmeridge Clay, and had mapped both as "Oaktree Clay." Webster had grouped with "Ferruginous Sand."**

C. Nil.

HASTINGS SANDS. A. (*a*) Fitton. (*b*) 1824. (*c*) **Ann. Phil., vol. viii,** n.s., p. 373. (*d*) **Hastings Sands.** (*e*) **Named because at** Hastings "the strata are well developed **and conspicuous,"** p. 377.

B. **The formation had been grouped with "Ferruginous Sand"** by Webster, with the "Iron Sand" by **Conybeare and** Phillips, and as they **remark at p. 136, "It is not possible to** assign the synonyme employed in the **geological works of Mr.** Smith."

C. The subdivisions of the **Hastings Sands into "Horsham** Stone," "Tunbridge Wells Sand," "**Cuckfield Clay,**" "**Grinstead Clay,**" "Wadhurst Clay," "**Ashdown Sand,**" "**Ashburnham Beds,**" were made by Messrs. Bristow and C. Le Neve Foster in the Geol. Survey maps, published 1864.

WEALDEN, as a group name, was first proposed by Mr. **Martin in his** "Memoir on a Part of Western Sussex," 1828, and **adopted** by Fitton in a paper *read in* 1827!! **Trans. Geol. Soc., ser. 2,** vol. iv., p. 103.

NOTICES OF MEMOIRS.

I.—ON THE METALS AND MINERALS OF UPPER BURMAH. By CAPT. G. A. STROVER, Political Agent, Mandalay.

[Published by order of the Government of India; Department of Agriculture, Revenue, and Commerce.]

THE Chief Commissioner having called for a report upon certain mineral products of this country, it has occurred to me that as many years have elapsed since any concise information has been given upon the subject of metals and minerals generally, and as our knowledge regarding these products has been greatly extended of late in consequence of increased intercourse between the British and Burmese Governments and the subjects of each nation, it will not be out of place, and of some interest, to give a brief sketch of the resources of Upper Burmah as regards the same.

Gold.—It has been generally supposed that Upper Burmah is not rich in itself as regards this metal, but there would seem to be good grounds for supposing that it exists very extensively. In former years the gold used in the country was imported from China to the extent of some 400 or 500 viss annually, but the imports have considerably decreased since the commencement of the Mahomedan rebellion in Yunan, and now do not exceed 200 viss per annum, the deficiency being imported from Rangoon. It is an article that is greatly used in the decorative art, and appears to be generally plentiful.

In the Mogoung district there would seem to be a gold-field that, properly worked, would prove very productive. Some years ago, Mr. Golding, of Australian experience, contracted with the King work one square mile of this field for a sum of Rs. 25,000 anually, for ten years, but unfortunately the district proved to be alarious and Mr. Golding succumbed to fever; he, however, prounced the fields to be equal to any in Australia, if not better. I a not aware that he succeeded in procuring much gold. Since then attempt has been made on the part of the Burmese Government work the mines.

To the north-east of Mandalay, in the Shan States, there is another ıld of gold. My information tends to show that here again, with ıergy and enterprise, considerable quantities of gold could be tracted, and the mines prove very productive; but the locality at esent is malarious, and but little gold is procured.

At Thayet-pein-yua, near the Myit-Nyay, on the road to Pyoungoo, to the south-east of Mandalay, the gold quartz is found in undance, the reefs cropping up from the ground, and there is ason to believe that very valuable gold-mines are in existence, and uld be worked and developed with little trouble. A Shan lately ocured from here a piece of quartz 3½ lbs. in weight that produced actly 2½ ticals of gold.

In the Yaw district, to the south-west of Mandalay, gold is obtained fair quantities in the alluvial deposits; it exists at Sagaing, Kannee, in-joo, and is also obtained from the Kyeend-ween river, and, ined, it is procurable from the sands of most of the streams between andalay and Mogoung. The natural conclusion from this profusion gold in the rivers and streams of Upper Burmah is that it exists large quantities *in situ* somewhere, and, as I have explained, this the case, and doubtless there are more deposits that have not been iscovered.

Silver is found in many localities in the Shan States to the east the Irrawaddy river, but the most prolific mines are those situated Bawyine, Kyouktch and Toung-byne, near Theebaw, to the north-ast of Mandalay. It is mixed with lead, and is in fact a rich gentiferous galena. One mine, the Kampanée, will yield as much 40 ticals of silver and 25 viss of lead from one basket of the ore, hile the poorest mine gives 4 ticals of silver and 30 viss of lead. ther mines exist, such as the Baudween, Baudweengyee and gaing. The metal is also found in other towns unmixed with ad. The supply of silver obtained hitherto has been sufficient for e requirements of the country in conjunction with the imports om Yunan.

Copper.—This metal is found in the Shan States, but is not worked. is also found at Kolen-myo and Sagaing; at Bawyine and Kolen-yo the malachite appears to be of a rich description. The copper sources of the Shan States do not appear to have been ever utilized any extent, and the deposits, which seem to be abundant, remain nature placed them. The Sagaing mines were worked in former mes by Chinese, but many years have elapsed now since they were abandoned. The surface ore is not promising. Most of the copper used in Upper Burmah is imported from China. It is plentiful in the Province of Yunan.

Iron.—Iron abounds in the Shan States, and the district of Pagan, to the south of Mandalay, is noted for it. A manufactory exists on a rough and ready scale in this district at Pohpah Toung, but the outturn is inconsiderable. To the west of Sagaing, for miles up the Irrawaddy river, the ore abounds—a rich hæmatite. His Majesty is now procuring iron works from England, and will before long have a large foundry, with all the requisite machinery, erected and at work at Sagaing. The surface hæmatite alone will feed it for years to come, if worked.

Two mining engineers are now awaiting the arrival of the works, and expect to proceed to Sagaing soon to commence operations.

Lead is found in abundance in the Shan States, and is extracted from galena. Considerable quantities of this metal could be obtained if such was desired. At present moderate supplies are procured, sufficient for the requirements of the land. It is also imported from Yunan.

Tin.—This metal exists in the Shan States to the south-east of Mandalay, but the mines have never been worked. The tin consumed in the country now is all imported.

Platinum is said to exist in the Shan States, and it seems probable that it does exist, but I have no reliable information on this point.

Graphite is found to the east of Nat-taik in large quantities on a low range of hills near the village Nyoke-toke. It is not utilized.

Coal.—This mineral is known to exist at Thingadaw, about 70 miles above Mandalay, on the western bank of the Irrawaddy; at Shuaygoo below Bhamo; at Meimbaloung in the Shan States east of Mandalay; to the south-west of Mandalay in the Yaw district, at Yaignaw, east of Nat-taik. It is found at Pagan and Shimpagah, and it is probable that it exists near Meuhla and Yeynangyoung. At Thingadaw the coal has been extracted, but it is of an inferior description and more resembles lignite than true mineral coal. An attempt was lately made here to ascertain the productiveness of the coal-beds. It is nearly certain that plenty of coal exists in the locality, and a few more borings would probably prove this. The coal-bed in the Shan States at Meimbaloung contains true mineral coal, and consequently a valuable coal. It has been inspected by an experienced mining engineer, and highly approved of as equal to the best English coal. There is little doubt that the beds are extensive, but unfortunately the distance inland is great, and no easy means are available for transporting the coal to the low lands; indeed, the only method at present is by floating it down mountain streams and rapids on rafts, which entails considerable risk and loss of coal. European skill and enterprise would soon make a safe route of one description or another if really required by the Government; it remains at present, with neighbouring wealth, where nature placed it, awaiting development in times to come.

Jade and Amber.—The quality and extent of these mines above

Mogoung is well known. They are both extensive and capable of development.

Sulphur.—This substance is not found in mass or in its native state in Upper Burmah, *sui generis*, but is found in efflorescent salts, and is manufactured from metallic sulphurets. The following is a list of localities where it is made, and the yearly average outturn:—

Mooda Myo, N.	3,000	Viss.*
Tsein-goon, E.S.E....	2,000	„
Kyouk-hoo, S.E.	3,000	„
Bawyine, Shan States, S.E.	6,000	„
Dybayen Myo, N.W.	4,000	„
Pagan Myo, west bank of the Irrawaddy	4,000	„
Toungthoo Einlay, E.S.E.	4,000	„
From the Bhamo District	2,000	„
Total Viss Yearly	28,000	= 39 tons 1¼ cwt.

At Toungthoo Einlay, to the south-east of Mandalay, sulphur is manufactured by the Toungthoo Shans, who sell their outturn to the King; at all the other places the mines are worked by His Majesty.

The Bawyine works have been increased during the past month by four extra furnaces, which will give about 5,000 viss more per annum. Sulphur appears to abound in the Shan States; in fact, at Bawyine, Kyouktah, Dybayen, Pagan, and Toungthoo Einlay the supply seems to be unlimited. It is found in the Tertiary blue clay from 12 to 20 feet below the surface, which is an alluvial deposit above the Old Red Sandstone; it is embedded in the clay, and consists of very hard metallic pyrites of some size.

The mode of extracting the sulphur is very simple. Common chatty-shaped vessels are made on the spot from the soft blue clay in which the ore is found. The larger vessel is filled with broken ore and placed on a fire, a clay retort being filled to the top, and communicating with the smaller vessel. The sulphur is thus sublimed and condensed, after which the retort is broken and a hollow tube of flower of sulphur extracted therefrom which is superior to that condensed in the vessel. Iron pyrites do not appear to be utilized in the manufacture of sulphur, and it is doubtful whether the Burmese could utilize it. Pyrites are to be found in abundance in parts of Upper Burmah and the Shan States. The imports from Yunan are also considerable every year.

It is manufactured in Yunan, and in the Shit-Pyee-Doung, or eight Shan States to the north-east of Bhamo, at present under the rule of the Chinese, or tantamount to the same. European sulphur can be purchased in the bazars at the rate of Rs. 3 per viss.

Saltpetre is manufactured at the following places in Upper Burmah:—Toungthoo Einlay, Ameerapoora, Shimpagah, Ong-benlay, Leen-gine, Sameet-koon, Pyogan, Aung-gyeen, Samoon-gyee, Oo-yun-galay, Shuaybo, Satoung-ma, Salem-myo, Yoon-doo, Myo-tha, Tsit-kine, Aloon, Tee-ber-Yeen, Myay-Yeen, Shin-bin-oon-Eni, Yua-

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[*] 8 Viss are equal to 1 Maund or 25 lbs. avoirdupoise.

shit-gyee, Enidyne Yua (Kyouksay, S.E.), East of Pagan (Yoongdaw Toung).

The yearly average outturn is about 40,000 viss. The manufacture is not prohibited as with sulphur, and considerable quantities are used in the preparation of fireworks.

The manufactures at Toungthoo Einlay, Eindyne, Kyouksay, Yoongdaw Toung, and Sameet-koon can produce very largely if required.

At Toungthoo Einlay the Toungthoo Shans in former times used to make from 20 to 25,000 viss of saltpetre per annum, but emigration to British territory has considerably reduced this.

The price of saltpetre is Rs. 50 per 100 viss. Many parts of Upper Burmah are well suited for its manufacture, the ground being well supplied with nitre.

Rubies, Sapphires, Garnets, etc.—These are found in abundance at Mogouk, Kyat-pyeen, to the north-east of Mandalay near Momeit. The ruby ground extends over a large area of hilly country. The gem sand is found from 3 to 15 feet below the surface soil, and the beds are then followed up. The method of working is primitive and rough, the consequence being that large rubies are seldom extracted intact.

Some years ago, a Mr. Bredamajee, a German Mineralogist, was located at these mines for the purpose of developing them, but, after a short stay, he got into trouble with the people, and was dismissed. He declared that, with careful working, rubies as large as pigeons' eggs could be extracted, and that the mines were very rich. At Mogoung also ruby mines exist, and very fair rubies have been found. The Sagyeen or marble hills, a short distance to the north of Mandalay, contain the gems as well, but they are of too light a colour to be valuable. They are, however, mixed with other rubies and disposed of.

Salt.—Extensive salt-fields exist at Shimpagah, a short distance above Mandalay, on the western bank of the Irrawaddy river. It is also obtained at other places in Upper Burmah on a small scale. Large quantities can be manufactured at Shimpagah, but imported salt is fast taking its place in the market. The hill people, though, appreciate to a certain extent the Shimpagah salt and mix it with European salt.

Petroleum.—This mineral oil is found at Yeynangyoung and Pagan, but information regarding it is so complete that it is hardly necessary to allude to it further. I will, however, make a few brief remarks.

There are at present about 150 wells worked at Yeynangyoung; the quantity of oil estimated as deliverable from these wells is 15,000 viss daily, of which 10,000 viss is taken by the contractor who supplies British Burmah, and 5,000 viss by the contractor who supplies Upper Burmah. The total yield of these wells is 6,000,000 viss per annum, or 9,375 tons. There are many abandoned wells, and wells that produce very small quantities of oil. At Pagan there are about 50 wells: they yield daily 1,500 viss of oil, which the earth-oil contractors, at present the Lay-myo-woon and one Moung

Tsanwah, are allowed to purchase. The oil from these wells is obtained in a more liquid state and more resembles naphtha. It is of a brackish nature, and is better suited for lighting purposes than the Yeynangyoung oil. The total supply of earth-oil in Upper Burmah now per annum is 66,000,000 viss or 10,312½ tons.

I have omitted to mention marble and limestone, but both abound.

Upper Burmah, with its metals and minerals, its forests, natural resources, productiveness of soil, and from its geographical position, situated as it is close to the teeming population of the Chinese empire, ought to be the richest country in Asia, and Rangoon one of the largest emporiums of trade. The productiveness of the soil, as regards cereals and other crops, is wonderful. The indigo plant, which is prolific in its growth, gives three crops per annum, and the dye would quite equal that of Bengal with careful and proper treatment in its manufacture. Paddy, wheat, cotton, cutch, grain, sesamum, sugar-cane, tobacco, tea, coffee, each has its own soil in abundance. Teak and other useful trees abound.

II.—M. HÉBERT'S ZONES IN THE CHALK.

THE general similarity of mineral character of the Chalk formation in England, and the habit of not carefully recognizing the different horizons from which fossils have been obtained, have to some extent militated against the further subdivision of the Chalk than that usually adopted in this country, viz. Upper White Chalk with flints, Lower Chalk without flints, and Chalk Marl. Lately some attention has been drawn to this subject, in papers read before the Geologists' Association by Mr. Caleb Evans 1870, Mr. Bedwell 1873, and Mr. Dowker 1869; also by Mr. Whitaker.

In France, however, for many years past, M. Hébert has specially studied the Chalk of the Paris basin, and communicated the results in sundry papers to the Geological Society of France, and which are published in the *Bulletin* for 1862, 1863, 1866, 1872, etc.[1] M. Hébert considers that the divisions are so clear that it is even possible to assign precisely where one ends, and the other begins; not only from the change of the fauna, but also from the general petrographic character. Besides, the superior surface of one division is always indurated and perforated to a greater or less extent, as is especially well shown at Meudon, where the White Chalk is seen in contact with the Superior Chalk or Pisolitic Limestone. From his researches M. Hébert has established the following subdivisions in ascending order:—1, La Craie glauconieuse; 2, La Craie marneuse à *Inoceramus labiatus;* 3, La Craie dur à *Holaster planus*; 4, La Craie à *Micraster cortestudinarium;* 5, La Craie à *Micraster coranguinum;* 6, La Craie à *Belemnitella quadrata* et *B. mucronata;* 7, La Craie supérieure (calcaire pisolitique). In general the lines of discontinuity correspond to gaps often considerable; thus between the Glauconitic Chalk (1) and Marly Chalk (2) there is wanting, in the north and east of the Paris basin, the green sands of the Maine, which have a great thickness in Touraine and le Perche, but which thin out to the east before reaching the Seine, and which are represented in the south by the *calcaire à Ichthyosaurolites*. Again, between the Marly Chalk (2) and the Chalk with *Holaster planus* (3), there are wanting the great beds of Hippurite Limestone, which form so important a feature in Southern Europe, and which, from the abundance of *Hippurites*, *Radiolites*, *Sphærulites*, and allied genera, and the comparative absence of *Ammonites* and allied forms, readily differentiate the Cretaceous era of Southern from that of Northern Europe. The zone of *Micraster coranguinum* (5) forms two series; the lower, well developed in the western, seems to be wanting throughout the eastern part of the Paris basin,[1] whilst the Chalk with *Belemnites mucronata* is absent in the sections exposed along the coast. These lacunæ afford a proof to some extent, according to M. Hébert, that the Parisian basin had already emerged during the deposition elsewhere of the missing strata, while at the same time it explains the presence and origin of the hardened surfaces during emersion and their perforation by atmospheric agencies. J. M.

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[1] M. Hébert communicated his views also to the British Association, Brighton, 1872, on the divisions of the Chalk of France, and paralleled them with those of the English Chalk, as seen from Folkestone, to St. Margaret-on-Cliff, Dover (see Reports, p. 104). See also M. Hébert's Classification in GEOL. MAG. 1869, Vol. VI. p. 200. Also MM. Cornet and Briart, on Belgian Chalk, GEOL. MAG. 1872, Vol. IX. p. 469. —J. M.

III.—ON FORAMINIFERA FROM THE TERTIARIES OF SAN FERNANDO, TRINIDAD.[2] BY R. J. LECHMERE GUPPY, F.L.S., F.G.S., ETC.

IN July, 1863, I brought under the notice of the Scientific Association the nature of the Asphalt Rock figured at page 38 of the Geological Report on Trinidad. I then stated that I had discovered that that rock consisted principally of the shells of *Orbitoides* and *Nummulina*, two genera of Foraminifera characteristic of Older and Middle Tertiary strata. In the interval between the reading and the printing of the paper in which my discovery was communicated to the Association, the same species of Foraminifera had been detected in the Miocene rocks of Jamaica, as noticed in a postscript to my paper. Previously however to this a few species of Foraminifera had been recorded from the Tertiaries of Haiti. The names of all these species will be found in my paper on the Tertiary Fossils of the West Indies, printed in the Proceedings of the Scientific Association, 1867, page 145.

Owing to the nature of the cliffs at San Fernando, great part of their face is often concealed for many years by earth fallen from the top, but occasionally the loose and disintegrated material is removed so as to expose the solid rock. This has happened lately to such an extent as to expose a large series of beds of which I had never previously been able to get a fair sight. These beds lie (in geological language) just above the Nucula-rock, which I have already described at pages 46 and 82 of the Proceedings for 1866 and 1867, and also in the GEOLOGICAL MAGAZINE, Vol. IV., p. 497. The mineral composition of these beds is argillaceous, with a large proportion of calcareous matter. Their colour is of a light greenish-grey, and the effect of weathering upon the matter is to develope a sort of spheroidal concretionary structure entirely independent of the original bedding and lamination. This spheroidal structure is probably partly or wholly induced by meteoric action. The beds are an upward continuation of the Nucula-bed, being similar in composition, and are part of the strata numbered 11 to 17 in the section given in my paper in the Journal of the Geological Society, vol. xxii., p. 571; and I propose to term them the Nodosaria-beds. They rarely contain any molluscan remains, but are stored abundantly with Foraminifera characteristic of deep water. I append a list of the forms I have been able to determine, including those of the Asphalt-bed. These determinations are only approximate, and the geologist will not expect from me a very exact statement of the varietal or subvarietal names of the forms, which can scarcely be given except by those who, like Messrs. Parker and Rupert Jones, have devoted great attention and study to these minute but beautiful shells. I trust, however, to place the material in the hands of those able to do more justice to the subject, and I only intend the present communication as a record and announcement of the discovery. So far as I am able to judge from the Foraminifera now discovered, the facts appear to lend a further support to my view that the Nucula-beds of Barbadoes and Trinidad were deposited in moderately deep water. The depth of water seems to have increased after the deposition of the Nucula-beds, as seems to be evinced by the Nodosaria-beds of Trinidad and the Polycystina-beds of Barbadoes.

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[1] Bull. Soc. Geol., 2 ser., t. 29, p. 446, pl. iv.

[2] From the Proceedings of the Scientific Association of Trinidad. December, 1872.

LIST OF FORAMINIFERA FROM THE LOWER MIOCENE STRATA OF SAN FERNANDO, TRINIDAD.

Nummulina ramond, Defr. var.*
Orbitoides Mantelli, Norton*
Amphistegina vulgaris, Orb.*
Spiroloculina nitida, Orb.
Glandulina lævigata, Orb.
Nodosaria glabra, Orb.
———— *hispida*, Orb.
———— *raphanistrum*, Linn
———— *ovicula*, Orb.
Nodosaria pyrula, Orb.
Dentalina elegans, Orb.
———— *filiformis*, Orb.
———— *communis*, Orb.
Orbulina universa, Orb.
Globigerina bulloides, Orb.
Polymorphina gibba, Orb.
Rotalia orbicularis, Orb.
———— *corallinarum*, Orb.

* These three species are only found in the Asphalt-bed and gypseous Marls.

Several other forms have not been satisfactorily determined.

IV.—GEOLOGICAL SURVEY OF CANADA. REPORT OF PROGRESS FOR 1871-72. By A. R. C. SELWYN, Director. (Montreal, 1872.)

THE progress of the Geological Survey ought to be very satisfactory to the Government of Canada, so ably and effectively has it been carried on for many years by Sir W. E. Logan, F.R.S., and for the last three years by the present Director, Mr. Alfred Selwyn, F.G.S. Since the first publication of the Reports in 1843, they have steadily and annually continued, and, together with other special reports, descriptions of organic remains, a great geological map of the Dominion of Canada, and many smaller maps and sections, comprise a vast and important amount of geological, mineralogical, and palæontological information, highly creditable to the Governments who supported it, and to Sir W. Logan and the staff who so efficiently have carried on the work.

The special reports contain papers chiefly by Dr. Sterry Hunt; one on the Geology of Newfoundland, by Mr. Murray; another on the Silurian Fossils of Anticosti, by Mr. Billings; at the same time during the progress of the Survey, the Canadian organic remains have been carefully illustrated, in four decades, the descriptions being furnished by Messrs. E. Billings, J. W. Salter, Prof. R. Jones, and Prof. Hall, besides the first volume of Silurian Fossils by Mr. Billings, and the fossil plants of the Devonian and Upper Silurian of Canada by Dr. J. W. Dawson, to be followed by others in preparation.

In the volume for 1871-72, besides the summary reports of the Director, Mr. Selwyn contributes the Journal and Report of preliminary explorations in British Columbia, assisted by Mr. Richardson, from which it appears the rock formations may be grouped under the following divisions in descending order, although the comparative absence of fossils renders their classification difficult,—1. Superficial deposits; 2. Volcanic series and coal and lignite of Main-land; 3. Jackass mountain conglomerate group; 4. Upper Cache creek group; 5. Lower Cache creek group: the fossils indicate a horizon between the base of the Devonian and the summit of the Permian; 6. Anderson River and Boston Bar group; 7. Cascade mountain and Vancouver Island crystalline series; 8. Granite, Gneiss, and Mica-schist series. The next report is on the Coal-fields of the east coast of Vancouver Island by Mr. Richardson, with a map of their distribution, and a note on the fossil plants by Dr. Dawson, and the Analysis of the Coals and Rocks by Dr. Sterry Hunt. Coal is found to some extent in the island, and the seams vary in thickness from four to seven feet, or even more, and vary in quality. The plants associated with the coal at Nanaino and North Saanich belong to a flora which has occasioned some controversy. "It was originally," says Dr. Dawson, "described by Lesquereux and Heer as Tertiary, being indeed very nearly allied to the Miocene of Europe." Newberry, however, on the evidence of the associated marine fossils, and on the analogy of the Cretaceous flora of Nebraska, regards it as of the latter age, and this is, I believe, the view more generally adopted.

The remaining reports in this volume are of the country between Lake Superior and Albany River, by Mr. R. Bell; the country between Lake St. John and Lake Mistassini, by Mr. W. McOuat; Surveys in the Counties of Leeds, Frontenac, and Lanark, in the Province of Ontario, showing the position of the worked gold-mines, and the course of the auriferous zone, by Mr. H. G. Vennor; on Geological Investigations in New Brunswick, by Prof. L. W. Bailey; and a Summary of the Statistics of Mines and Mineral Produce of the Dominion, by Mr. C. Robb.

REVIEWS.

I.—Untrodden Peaks and Unfrequented Valleys: A Midsummer Ramble in the Dolomites. By Amelia B. Edwards. 8vo. pp. 385. (London: Longmans, Green & Co. 1873.)

IT is nearly ten years since we drew attention in these pages to this romantic and primitive mountain region of the Tyrol,[1] still, to a great extent, untrodden and unfrequented by the tourist, and where Cook's Excursions are as yet unknown. It is pleasant to find that, in these days of luxurious ease and comfort, ladies can be found equal to the task of roughing it for weeks in a district where there is but one good road, where the inns are not only few and far between, but are often of the humblest kind, where it is impossible to travel in the heart of the country save on foot, or on mule-back; where telegraphic communication is unknown, and where letters travel slowly and are delivered irregularly. But as a set-off against these discomforts, the author writes: "It is difficult to speak of the people, of the climate, of the scenery, without risk of being thought too partial or too enthusiastic. To say that the arts of extortion are here unknown,—that the old patriarchal notion of hospitality still survives, miraculously, in the minds of the inn-keepers,—that it is as natural to the natives of these hills and valleys to be kind, and helpful, and disinterested, as it is natural to the Swiss to be rapacious,—that here one escapes from hackneyed sights, from overcrowded hotels, from the dreary routine of table d'hôtes, from the flood of Cook's tourists,—is, after all, but to say that life in the South-eastern Tyrol is yet free from all the discomforts that have of late years made Switzerland unendurable; and that for those who love sketching and botany, mountain-climbing and mountain air, and who desire when they travel to leave London and Paris behind them, the Dolomites offer a 'playground' far more attractive than the Alps."

Till within the last six or eight years—that is to say, till the publication of Ball's Guide to the Eastern Alps in 1868, and the appearance of Messrs. Gilbert and Churchill's joint volume in 1864—the Dolomite district was scarcely known even by name to any but scientific travellers. Messrs. Sedgwick and Murchison described the Eastern Alps so long ago as 1835,[2] and a geologically coloured map and sections have since appeared (1860, 4to.), by the Baron von Richthofen. Later still the country has been surveyed by the Austrian Geological Survey.

The district included in Miss Edwards's itinerary occupies that part of the south-eastern Tyrol which lies between Botzen, Bruneck,

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[1] See the Geol. Mag., Vol. I., 1864, p. 38. Reviews:—"The Dolomite Mountains. Excursions through Tyrol, Carinthia, Carniola, and Friuli in 1861-3." By Josiah Gilbert and G. C. Churchill, F.G.S. 8vo. pp. 576. (London: Longmans, Green & Co. 1864.)

[2] "On the Structure of the Eastern Alps, with sections through the Newer Formations on the Northern Flanks of the Chain, and through the Tertiary deposits of Styria, etc." Trans. Geol. Soc., 2nd series, vol iii., p. 301, read 1829-30.

Innichen, and Belluno. Within the area thus roughly indicated are situated those remarkable limestone mountains called the Dolomites. The district may be most easily approached from either Venice, Botzen, or Bruneck. All that is grandest, all that is most attractive to the artist, the geologist, and the Alpine climber, lies midway between these three points, and covers an area of about thirty-five miles by fifty. All that the author describes lies within this narrow radius.

The book is accompanied by an excellent route-map of the district, and the scenes and places visited are charmingly illustrated by Mr. Whymper, from sketches by the author, forming nine full-page illustrations and eighteen wood-engravings in the text.

By the kindness of the publishers we are able to reproduce some examples of these, with a brief reference to which we shall close this notice. "Passing Schulderbach, a clean-looking road-side inn, we came presently in sight of the Dürren Sea, a lovely little emerald-

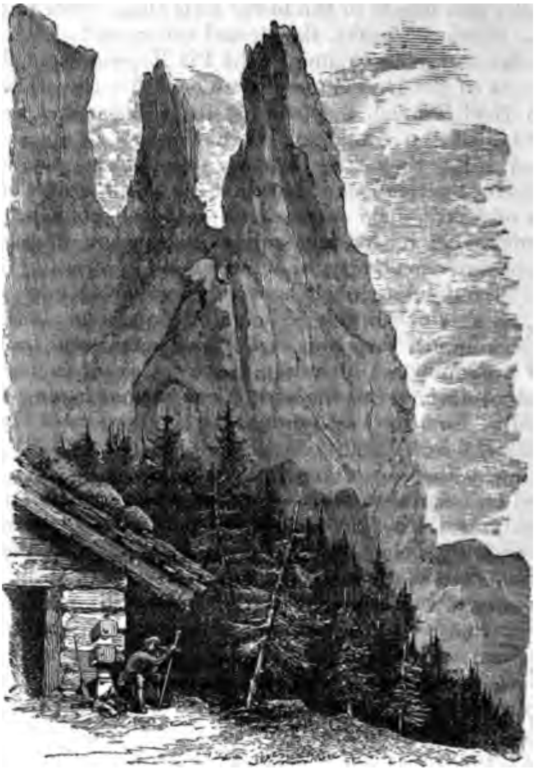
The Drei Zinnen.

een lake, streaked with violet shadows, and measuring about three-ıarters of a mile in length. Great mountains close it in on all les, and the rich woods of the lower hills slope down to the water's lge. The clustered peaks, the eternal snows and glaciers of Monte ristallo; the towering summit of the Piz Popena; and the extraornary towers of the Drei Zinnen come one after the other into view. s for the Drei Zinnen, they surpass in boldness and weirdness all e Dolomites of the Ampezzo. Seen through an opening between o wooded hills, they rise abruptly from behind the intervening ateau of Monte Riano, as if thrust up from the centre of the earth ce a pair of tusks. No mere description can convey to even the ost apprehensive reader any correct impression of their outline, eir look of intense energy, of upwardness, of bristling irresistible rce. Two barren isolated obelisks of pale, sulphurous, orange-streaked, mestone, all shivered into keen scimitar blades and shark-like teeth wards the summit, they almost defy the pencil and quite defy the n. For the annexed illustration, however, so far as mere truthfules of actual form goes, the writer can vouch, having sketched it ry carefully from the best point along the borders of the lake."

The author, describing the Sasso di Ronch (Plate XIII.), says:—

"Arriving at the top of the Col, we came suddenly upon a most ıexpected and fantastic scene—a scene as of a mountain in ruins. r not only is the whole appearance of the Sasso changed in the rangest way by being seen in profile, but, behind the ridge on hich Sasso stands, there is revealed a vast circular amphitheatre, ce the crater of an extinct volcano, strewn with rent crags, precices riven from top to bottom, and enormous fragments of rock, any of which are at least as big as the clock-tower at Westminster. l these are piled one upon another in the wildest confusion; all e prostrate, save one gigantic needle, which stands upright in e midst of the circle, like an iceberg turned to stone. Meanhile here, on the ridge, apart and alone, like a solitary remnant an outer battlement left standing beside a razed fortress, rises a height of at least 250 feet above the grass at its base, the Sasso Ronch. Seen thus in profile, it is difficult to believe that it is the me Sasso di Ronch which one has been looking at from below. It oks like a mere aiguille, or spire, disproportionately slender for its ight, and curved at the top, as if just ready to pitch over. Some ıe has compared the Matterhorn to the head and neck of a warrse rearing up behind the valley of Zermatt; so might the Sasso Ronch from this point be compared to the head and neck of a raffe. Standing upon its knife-edge of ridge—all precipice below, l sky above, the horizon one long sweep of jagged peaks—it makes wild and weird a subject as ever I sat down to sketch before or since."

The Aiguilles of the Schlern (p. 380) form part of a vast panorama peaks, including the Marmolata and Tofana, and many a famous ak besides. Its three nearest neighbours, the Lang Kofel, Platt ogel, and Schlern, are alone visible; the rest are wrapt in clouds toıy, only the Sella and Guerdenazza Massives stand free from vapour. "The height of the Schlern," says Mr. Ball in his Guide to the Eastern



The Aiguilles of the Schlern.

Alps, "is only 8405 feet; but it stands up in such a grand solitary way, and its precipices are so bare and vertical, that it looks higher than many more lofty Dolomites. The easiest ascent is from Völs, and the view from the top, though said not to be so complete as that from the Ritterhorn nearer Botzen, is extremely fine, and comprises the Adamello, Oetler, Oetzthal, and Antholzer Alps. The south-eastern horizon, however, and consequently all the Primero Dolomites, are concealed by the near mass of the Rosengarten. No mountain in the Alps has acquired so great a reputation amongst botanists for the richness of its flora, and the number of rare plants it produces, as the Schlern."

Miss Edwards is a delightful companion for a summer ramble among the Dolomites: she evidently possesses sufficient power and activity to resist fatigue, and enters thoroughly into the enjoyment of the mountain country she describes and delineates in so graphic and charming a manner. We wish we could give longer and more amusing extracts from the book, of which there is no lack. Such a volume is sure to be well received, as it justly deserves, not only in England, but among her American friends, to whom the book is dedicated.

II.—BALL'S ALPINE GUIDES. NEW EDITIONS, 1873. IN SEVEN PARTS, NAMELY :—The BERNESE ALPS, including the OBERLAND ; SOUTH-WESTERN ALPS, including DAUPHINÉ and PIEDMONT, from NICE to the LITTLE ST. BERNARD ; NORTH SWITZERLAND, including the RIGHI, ZURICH, and LUCERNE ; the ST. GOTHARD PASS and the ITALIAN LAKES ; EAST SWITZERLAND, including the ENGADINE and LOMBARD VALLEYS ; NORTH TYROL, and BAVARIAN, and SALZBURG ALPS ; the STYRIAN, CARNIC, and JULIAN ALPS. (London : Longmans, Green & Co.)

THESE handy little knapsack companions are prepared expressly for the convenience of tourists by Mr. John Ball, F.R.S., late President of the Alpine Club, a gentleman eminently qualified to direct our steps among the peaks, passes, and glaciers of the Alps, with every foot of which he is so familiar.

Each of these compact little half-crown parts is *complete in itself*, containing a separate district divided into sections, and these again into routes ; each furnished with its key-map and maps of sections or districts.

Three more will be ready (so the publishers assure us) immediately, namely :—Mont Blanc and Monte Rosa ; Central Tyrol, including the Gross Glockner ; South Tyrol, and Venetian or Dolomite Alps ; thus completing the set of Guides in ten separate parts.

Panting for freedom and an alpenstock, with August upon us, and the temperature not far short of 100° in many a London studio, what more refreshing and acceptable sight than these charming little green-covered octavo volumes, telling of rivers of ice miles in length, sufficient to satisfy all London with iced drinks for the rest of the year ; of glacial moraines, *roches moutonnées* and *blocs perches :* let us away, with Mr. Ball for our guide, to geologise, botanise, to sketch or to loaf, and lay in a store of health, strength, and pure enjoyment, over the Bernese Oberland, by the sunny Italian lakes, or amidst the Styrian Alps and the Dolomite Mountains.

Let us take our stand, in imagination, for a few minutes upon the central group of the Bernese Alps. "The most remarkable characteristic in the orography of this group is that whereas the W. portion of that chain consists of a single series of summits, with comparatively short projecting buttresses, the higher group presents a series of longitudinal ridges parallel to the axis of the main chain, and separated from each other by deep valleys that form the channels of great glaciers. Thus the Tschingel glacier and the Gasterenthal separate the portion of the main range lying between the Gemmi and the Mittaghorn from the equally high parallel range of the Doldenhorn and Blumlis Alp on its N. side. To the S. the same portion of the main range is divided from the still higher parallel range whose summits are the Aletschhorn and the Bietschhorn by the Lötschenthal and Lötschen Glacier. To this again succeeds the deep trench through which the lower part of the Aletsch Glacier flows down to the Rhone, inclosed by the minor ridge that culminates in the Aeggischhorn.

"The grandeur and beauty of the scenery of this district, which is best known as the Bernese Oberland, have long obtained for it a just celebrity; and since strangers first began to visit the Alps, the names of Grindelwald, Lauterbrunnen, and Interlaken have been famous. It was long, however, before the interior portion of the range and the great glaciers that flow down towards the Rhone on its southern flanks were known and appreciated by strangers." (p. 54.)

The exploration of the Oberland District was commenced early in this century by the brothers Meyer of Aarau. The were followed by Hugi, a mountaineer of great enterprise and perseverance.

Still later, in 1841, M. Agassiz established a temporary dwelling on the Aar Glacier, and commenced, together with Desor, Studer, Forbes, and others, a series of scientific observations and explorations, which have been carried on in later years by successive members of our English Alpine Club, until we have arrived not only at our present very comprehensive orographical acquaintance with the Alps, but have acquired a better knowledge of the physics of ice and its power as a geological agent to erode rock-surfaces, and to produce those vast accumulations of Boulder-clay which in past ages were extensively formed in this country by the grinding action of glaciers, which then covered all the high lands of Britain and Ireland, as they now do the plateau of Greenland and the higher valleys of the Bernese Alps.

"There is no part of the Alps (writes Mr. Ball) where arrangements for the accommodation of foreign visitors, and for extracting at the same time the utmost possible amount of coin from their pockets, are so completely organized as in this district, and especially in the valleys belonging to the Canton Berne. On the one hand, it is of no little convenience to a stranger to find inns, more or less comfortable, at almost every spot where he can reasonably desire to pass the night, along with guides and abundant means of conveyance; but, on the other, it is not pleasant to find the entire population banded together with no other seeming object than to make a profit out of his passage. Along the frequented tracks of the Great Scheidegg and the Wengern Alp, the wayfarer is at every half-mile assailed by some new appeal to his pocket. Sometimes it is by a live chamois or marmot, sometimes by an echo to be awaked by a horn or a chorus of discordant children's voices, anon it is by bits of pyrites or quartz" (or even green bottle-glass melted into lumps, and then fractured so as to resemble a native mass of rock-crystal!), "or by specimens of wood-carving, that toll is levied on the stranger; but the most effectual and simplest device is to put a wooden gate across his track, and keep a ragged child in readiness to open the gate on his approach, and tender its palm for the reward. The best way to save wear and tear of temper and good humour is to be provided with a moderate supply of small coin, and suppress all outbursts of virtuous indignation."—Ball's *Bernese Oberland*, p. 55.

Fortunately a tariff is established by the Cantonal authorities for carriages, horses, guides, porters, etc., so that foreigners have the advantage of knowing how far they are liable to be mulcted by the artless natives of the mountains. All these material pieces of information, together with hotels and guides, are carefully recorded by Mr. Ball, to whom our best thanks are due for his very convenient little series of Alpine Guide-books.

III.—GEOLOGICAL MAP OF THE UNITED STATES, COMPILED FOR THE 9TH CENSUS, 1872. By C. H. HITCHCOCK and W. P. BLAKE.

(The base is the Military Map of the United States, by permission of the Chief of Engineers.)

THE Reports of the various State Surveys published from time to time have already made us acquainted, in detail, with the Geology of the Great American Republic, and also with its vast Western Territories, now connected to and rapidly becoming amalgamated with the more completely occupied Eastern States by the Great Pacific Railroad.

It is now more than fifteen years ago since Jules Marcou published his map of parts of North America.[1] The numerous publications of Professor Dana, and Professor Rogers's Geological Map of the United States, including British North America,[2] and the excellent Canadian Map prepared by Sir William Logan, and exhibited at the 1862 Exhibition, as well as those given by Lyell,[3] have made us generally acquainted with the broad features of American Geology. Some idea may be formed of the basis upon which the present Map rests when we recall for a moment the rapid progress which has been made in Geological research in America within the past fifteen years, notwithstanding the sad interruption to all such peaceful labours caused by the unhappy struggle between North and South, the recollection of which happily is now rapidly sinking into the limbo of the past.

The following is a tolerably complete[4] list of the Surveys now in progress, or which have already made Reports or published Maps, etc., relating to the Geology of the various States and Territories named.

Alaska Territory, by W. H. Dall.
California State, by J. D. Whitney and C. King.
Colorado, by Dr. F. V. Hayden.
Colorado River, by Lieut. J. C. Ives.
Illinois State, by A. H. Worthen.
Indiana State, by E. T. Cox.
Iowa State, by Dr. C. A. White and R. D. Owen.

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[1] Boston, 1853. Zurich, 1858.

[2] Published in Keith Johnston's Physical Atlas, 1855.

[3] Travels in North America, with Geological Observations on the United States, Canada, etc., 1845. 2 vols. 8vo.—Second Visit to the United States of North America. 2 vols. post 8vo. 1st edition 1849, 2nd edition 1850.

[4] Our sources of information being limited, we trust our American friends will excuse any important omissions, if such there be. We have confined our list to State Geological Reports.

Maine State, by Prof. C. H. Hitchcock.
Massachusetts State, by Dr. E. Hitchcock.
Minnesota State, by Robt. D. Owen.
Missouri State, by G. C. Swallow, Dr. F. V. Hayden, F. B. Meek.
Nebraska Territory, by R. Dale Owen, Dr. F. V. Hayden.
New Hampshire State, by Prof. C. H. Hitchcock.
New Jersey, by Prof. H. D. Rogers.
New Mexico, by Dr. F. V. Hayden.
New York State, by W. W. Mather, Dr. E. Emmons, L. Vanuxem, and J. Hall.
Ohio State, by Prof. J. S. Newberry.
Pacific Railway Reports, by F. B. Meek and others.
Pennsylvania, by Prof. H. D. Rogers.
Rocky Mountains, by Dr. F. V. Hayden.
South Carolina, by Oscar M. Lieber and M. Tuomey.
Tennessee State, by J. M. Safford.
Vermont, by Dr. E. Hitchcock and others.
Wisconsin, by Robt. Dale Owen.
Wyoming, etc., by Dr. F. V. Hayden.
The Yellowstone River, by Dr. F. V. Hayden.

Many of these State Surveys have published numerous volumes on the Geology and Palæontology of their several States, accompanied by maps and sections and excellent plates of Fossils.

The Survey of the State of New York (one of the oldest) has published twenty-one volumes, comprising the Natural History and Agriculture of the State.

Illinois, Iowa, Indiana, California, and other States, have also achieved wonderful and rapid results, as attested by their numerous and recently published works, most of which will be found noticed in the pages of the GEOLOGICAL MAGAZINE.

The present Map, compiled for the 9th Census, is based on the Military Map of the United States, by permission of the Chief Engineer, and exhibits the physical features so far as the lakes and river-systems are concerned, and upon which the geological formations are coloured.

One feature which has probably influenced to some extent the direction of the great river-systems of America (as pointed out by Dana) is the comparative development of the older and harder rocks on the eastern and western sides of the Continent—and to which probably its subtriangular form is due—the central area being chiefly occupied by the Cretaceous and Tertiary rocks, although traces of both these are found on the seaboard of the east and west coasts.

Although on a comparatively small scale (36 by 24 inches), the coup d'œil presents us with a fair notion of the geological features of this vast and well-favoured country. To the geologist, as to the public at large, the most important area to be noticed at this time is that occupied by the Carboniferous system; and if arguments were needed to favour the old-established belief that the general movement of peoples is in a westerly direction, and that the country of the future is North America, let our American cousins point with perfect confidence to their almost inexhaustible Coal-fields, which are, practically speaking, unworked, so great hitherto has been the supply of surface-fuel in the clearing of boundless forests, now changing into broad fields of corn and pastures for vast herds of cattle.

The older rocks, named Eozoic by the authors, comprise all the formations earlier than the *Paradoxides*-beds, including the oldest-known metamorphic Appalachian Schists.

Above these occur the subdivisions of the Palæozoic rocks, including the Silurian, Devonian, and Lower Carboniferous, the Coal-measures and the Permo-Carboniferous rocks. These rocks, it will be observed, occupy a very large district in the Eastern States, but few being found in the Western Territories (and those being Devonian), from which it will be seen that the Carboniferous series are chiefly confined to the same Eastern area.

The Triassic and Jurassic rocks appear to occupy, on the map, a comparatively limited portion of the whole country, whilst the Upper Mesozoic or Cretaceous rocks cover a very extended central area and also a narrow band on the Pacific coast, as well as in the south-east and north-east, where it borders the older Palæozoic rocks of the Mississippi and New Jersey.

The Cainozoic series occupy not only a large portion of the central region, but also spread over and fill up the depressions amidst the older rocks of the western mountain-ranges, in which district also the chief masses of the igneous rocks are found, for there appear to be no traces of them marked on the map in the Eastern districts. These volcanic rocks are classed, in the explanation of colours given on the map, under the Cainozoic period.

Perhaps the remarkable progress of the United States Geological Surveyors, is most clearly indicated by the great additions made to our knowledge of the several formations composing the vast Western Territories of the Union, and by the better defined areas of the Silurian, Devonian, and Laurentian rocks in the Eastern States.

Contrasted with the older map by Prof. Rogers (given in Keith Johnston's Physical Atlas, 1855), the colouring of the new map appears somewhat too heavy and opaque, rendering names of places less easily legible; but this is probably a fault of the earlier copies, which is sure to be remedied in the later printed ones, or, in a new edition. The adoption of cosmopolitan terms for the great rock-formations, in place of the fantastic ones used by Rogers, but now generally discarded, is a very important step towards a universally accepted rock nomenclature, which will prove of enormous benefit to geological science the world over.

IV.—Descriptive Guide to the Fossil Collection in the Museum of the Leeds Philosophical and Literary Society. By L. C. Miall. (Leeds, 1873.)

THIS very cheap and useful guide will be of great service to those who may visit the fine collection of Fossils in the Leeds Museum, as it contains in a small compass much valuable information which will enable even the non-scientific visitor to appreciate more fully the teachings to be derived from the study of the remains here preserved illustrative of the past life of the globe.

A general notice is given of the geological characters of the different formations, including the geology of Leeds, as well as brief descriptions of the natural history and relation to existing forms of the more important fossil plants and animals in the collection, and a list of works and papers on Yorkshire Geology, the whole guide reflecting much credit on the Curator who prepared it.

REPORTS AND PROCEEDINGS.

GEOLOGICAL SOCIETY OF LONDON.—June 25th, 1873.—Joseph Prestwich, Esq., F.R.S., Vice-President, in the Chair.—The following communications were read:—1. "On six Lake-basins in Argyllshire." By His Grace the Duke of Argyll, K.T., F.R.S., President.

The author referred to the part ascribed to glacial action in the formation of lake-basins, and described the basins of six lakes in Argyllshire, the characters presented by which seemed to him inconsistent with their having been excavated by ice. Among these lakes were Loch Fyne, Loch Awe, Loch Leckan, and the Dhu Loch. The upper part of Loch Fyne was said to be cut off from the rest by a bar of islands, with only one or two deeper passages. The country about Loch Fyne was described as consisting of Upper and Lower Silurian mica-slates, which have been violently contorted, their normal strike being indicated by the direction of the valleys. Loch Fyne occupies a niche in the slope of the rocks, having an escarpment on one side and the shelving strata on the other. The existence of a fault along the line of the loch was probable, but could not easily be ascertained. Its greatest depth in this part was said to be 84 fathoms. Its banks show marks of glaciation, whereon the surface is well adapted for their preservation; the strongest marks are on those rock-faces which look up the loch. Between Loch Fyne and Loch Awe the mica-slates are interstratified with granite, which the author believed to have been forced up between the planes of stratification by the pressure caused by the falling in of the mica-slates, as fragments of the latter rock are imbedded in the granite. The author described the different structure of the two banks of Loch Awe, the upper part of which seemed to him to lie in a synclinal trough; and its waters were only prevented by a low col from finding their way to the Atlantic in this direction, instead of from the lower end. The formation of the basin of Loch Awe seemed to the author to be due solely to geological structure, as was also the case with another lake beyond the head of Loch Awe. The surrounding country was said to be full of smaller lake-basins, the formation of which might be due to the denudation of the softer mica-schists lying below the granite ridges, but in some cases the basins were excavated in the latter. Loch Leckan was mentioned as an example. It is about a mile long, from 100 to 200 yards broad, and no less than 18 fathoms deep. At the top of its southern bank, which consists of granite, there is another lake (Loch-na-Craig), about 200 yards broad and 9 fathoms deep. The surrounding hills are low, and there appeared to be no source which could furnish ice to excavate a lake of such depth as Loch Leckan; and further, the author contended that if one of these two basins were excavated by ice, the other could hardly have been preserved intact. Two other lakes, excavated on the summits of granite ridges, were mentioned; and the author could not conceive how either a glacier or an ice-cap could have produced such basins. The Dhu Loch, separated from Loch Fyne by a bank of gravel about a mile broad, is entirely in detrital matter, which the author thought might have been accumulated in its present form by the sea beating against the end of a glacier. From its position and level, the Dhu Loch rises and falls with the tide; and it would appear that it formerly extended some miles further up the valley, where the author had found clays containing a mixture of marine and freshwater Diatomaceæ. In five of these cases the author thought it was impossible that the basins were due to glacial action.

DISCUSSION.—Prof. Ramsay dissented from the concluding parts of His Grace's remarks, which might lead his hearers to suppose that he had attributed all lake-basins, without exception, to glacial action. On the contrary, he had in all cases maintained that they were due in many instances to certain original valleys, due to various agencies, both of superficial denudation and of internal disturbance, and acting at all periods of the earth's existence. These earlier inequalities had indeed received their final configuration from the action of ice; and it was only certain of the more shallow basins to which he assigned a purely glacial origin. He disclaimed any such ideas, which he regarded as utterly irreconcilable with the phenomena of nature. As to the sides of the basins, he had had great experience, and nowhere had he seen a case in which he could regard the existence of a lake as merely due to a fracture of the rocks. In Scotland it was well known that most of the contortions of the rocks had taken place before the deposition of the Old Red Sandstone. He wished to know whether during the ages that had passed since that time all atmospheric agencies had been suspended. On the contrary, their operation had been such that thousands and thousands of feet of strata had by their means been removed. Nowhere was this more evident than in considering the structure of the Carboniferous areas, where enormous denudation had taken place long before even the coal had been deposited. How then could we ignore this operation in other parts of the country? As to faults, he submitted that their existence must be proved rather than assumed. Did they exist, they were not gaping faults, but closed; and he regarded it as physically impossible for such hollows as those in which the lakes were found to be due to such causes. Even if fractures existed, they would not remove the matter of which the rocks were composed. They might however, constitute lines of weakness, along which denuding agents might more readily work. As to the lakes on the summits of ridges, he would not pretend to account for what he had not seen; but he cited similar lakes in the Grimsel, which presented similar phenomena, and which he regarded as undoubtedly due to glacier action. Even on the top of *roches moutonnées* such basins were found; and though he might not know the exact circumstances under which they were found, they were undoubtedly due to ice-action. If in Switzerland and other glaciated countries of the present day we found the configuration of the country presenting similar phenomena to those of Scotland, he considered that there was ample ground for attributing both to the same cause, and there was no need of invoking other causes. It was moreover to be borne in mind that though similar contorted gneissose rocks to those of Scotland occurred in several other countries, it was only in those which had been glaciated that such numerous lake-basins were to be seen.

The Duke of Argyll, in reply, agreed with Prof. Ramsay that it was not in all cases that the lake-basins were due to disturbance of the rocks; and indeed in some of the most contorted districts lakes were rarely present. All his contention was that whatever may have been the denuding agent, it was not in all cases ice.

2. "Description of the Skull of a Dentigerous Bird (*Odontopteryx toliapicus*, Owen), from the London Clay of Sheppey." By Prof. Richard Owen, F.R.S., F.G.S.

The specimen described by the author consisted of the brain-case, with the basal portion of both jaws. The author described in detail the structure and relations of the various bones composing this skull, which is rendered especially remarkable by the denticulation of the alveolar margins of the jaws, to which its generic appellation refers. The denticulations, which are intrinsic parts of the bone bearing them, are of two sizes,—the smaller ones about half a line in length, the larger ones from two to three lines. The latter are separated by intervals of about half an inch, each of which is occupied by several of the smaller denticles. All the denticles are of a triangular or compressed conical form, the larger ones resembling laniaries. Sections of the denticles show under the microscope the unmistakable characters of avian bone. The length of the skull behind the fronto-nasal suture is two inches five lines; and from the proportions of the fragment of the upper mandible preserved, the author concluded that the total length of the perfect skull could not be less than between five and six inches. The author proceeded to compare the fossil, which he declared to present strictly avian characters, with those groups of birds in which the beak is longer than the true cranium, a character which occurs as a rule in the *Aves aquaticæ*. He stated that none of the Waders have the nostrils so remote from the orbits as in *Odontopteryx;* and this character, with the absence of the supraorbital gland-pit, limits the comparison to the Totipalmates and Lamellirostrals. The former are excluded by their not having the orbit bounded by a hind wall as in *Odontopteryx*, and in this and other peculiarities the fossil seems to approach most nearly to the Anatidæ, in the near allies of which, the Goosanders and Mergansers, the beak is furnished with strong pointed denticulations. In these, however, the tooth-like processes belong to the horny bill only, and the author stated that the production of the alveolar margin into bony teeth is peculiar, so far as he knows, to *Odontopteryx*. He concluded, from the consideration of all its characters, "that *Odontopteryx* was a warm-blooded, feathered biped, with wings; and further, that it was web-footed and a fish-eater, and that in the catching of its slippery prey it was assisted by this pterosauroid armature of its jaws." In conclusion, the author indicated the characters separating *Odontopteryx* from the Cretaceous fossil skull lately described by Prof. O. C. Marsh, and which he affirms to have small, similar teeth implanted in distinct sockets.

Discussion.—Mr. Seeley had given much study to the Pterosaurians, to which the author had indicated the affinities of *Odontopteryx*. He had in *Ornithocheirus Oweni* found what appeared to be identical structure with that of the bird, and it therefore appeared to form a new genus of Pterosaurians. Both in the frontal and occipital regions of the skull he recognized affinities to *Ornithocheirus;* but it presented even more distinctly marked reptilian affinities. The position of the brain was also quite as far back in the skull, and the quadrate bone also presented curious analogies, so much so as to be almost identical. The sutures presented characters similar to those exhibited by immature birds; and he thought that the separation of the bones in this example showed affinities to the anserine type. He was quite prepared to regard the fossil as that of a bird rather than of an Ornithosaurian. He inquired as to the character of the palatal bones.

Mr. Charlesworth inquired as to the light in which this discovery would be regarded by evolutionists.

Prof. Owen briefly replied.

3. "Contribution to the Anatomy of *Hypsilophodon Foxii*, an Account of some recently acquired Remains of this Dinosaur." By J. W. Hulke, Esq., F.R.S., F.G.S.

After referring to Professors Owen and Huxley's descriptions of the Mantell-Bowerbank skeleton in the British Museum, and to the paper by the last-named gentleman on the skull of this Dinosaur read at a meeting of this Society in 1870, the author communicated details of its dentition, the form of its mandible, and that of the cones of the shoulder and fore limb, and of the haunch and hind limb, hitherto imperfectly or quite unknown. The resemblance to *Iguanodon* is greater than had been supposed, but the generic distinctness of *Hypsilophodon* holds good.

Discussion.—Prof. Owen remarked that palæontologists generally were interested in obtaining such additional evidence of the generic characters of *Iguanodon* as Mr. Fox's valuable discovery of the skull and other remains of the small species in the Isle of Wight Wealden might supply; but such desirable information, especially as regards the cranial structure of the herbivorous Dinosaurs, is shut out if those remains are shown to belong to a distinct genus. In the paper to that end in the 'Quarterly Journal' for 1870, p. 3, the only teeth of the so-called *Hypsilophodon* known to the writer, were those of the upper jaw, and these were not entire; the portion of crown answering to the serrated portion in *Iguanodon* was worn away. Mr. Fox was therefore justified in rejecting Professor Huxley's genus *Hypsilophodon*, although he might believe the statement that such serrations were characteristic of the teeth of *Iguanodon*, especially when emphasized by the phrase "so characteristic"; the fact being, however, that marginal serrations characterize the apical half of the crown in the Dinosaurian genera *Scelidosqurus* and *Echinodon* as in *Iguanodon*. What are truly characteristic of the upper molars of that herbivorous Dinosaurian are the ridges on the outer surface of the crown, which ridges, being also present in Fox's *Iguanodon*, and supposed to be peculiar thereto, suggested to Professor Huxley the term *Hypsilophodon*. But the lower molars of *Iguanodon* are equally ridged, but on the opposite side to those above, viz. the inner side; and the marginal serrations extend nearer to the base of the crown. Now the lower molars of the small *Iguanodon*, also found, with the mandible, by Mr. Fox, show this generic character, and vindicate the taxonomy of their discoverer. We may rest assured, therefore, that the sloping edentulous symphysial part of the mandible of the great *Iguanodon* had a downbent edentulous part of the premaxillaries applied to it, such as the fore part of the skull of *Iguanodon Foxii* exhibits. Without a knowledge of the characters of both upper and lower molars of this small *Iguanodon*, no one in quest of the truth of the matter could affirm "that the teeth of this reptile were perfectly distinct from those of *Iguanodon Mantelli*." In the last plate of Prof. Owen's 'Monograph' for the forthcoming volume of the Palæontographical Society, the mandible and mandibular teeth are figured, and he had hoped to have received a proof to show to the meeting. The mandibular teeth exhibited by Mr. Hulke were identical with those previously discovered by Mr. Fox. In the 'Monographs' the evidence will be found of the specific, but not generic distinction of Mr. Fox's small Dinosaur from the large *Iguanodon Mantelli*.

4. "On the Glacial Phenomena of the 'Long Island,' or Outer

Hebrides." By James Geikie, Esq., F.R.S.E., F.G.S., of H.M. Geological Survey of Scotland.—First paper.

The author commenced by describing the physical features of Lewis, which he stated to be broken and mountainous in the south, whilst the north might be described as a great peat moss rising gradually to a height of about 400 feet, but with the rock breaking through here and there, and sometimes reaching a higher elevation. The north-east and north-west coasts are comparatively unbroken, but south of Aird Laimisheadar in the west and Stornoway in the east, many inlets run far into the country. The island contains a great number of lakes of various sizes, which are most abundant in the southern mountain tract and in the undulating ground at its base. The greater part of Lewis consists of gneiss, the only other rocks met with being granite and red sandstone, and conglomerate of Cambrian age. The stratification of the gneissic rocks is generally well marked; the prevalent strike is N.E. and S.W. with S.E. dip, generally at a high angle. The author described in considerable detail the traces of glaciation observed in the lower northern part of Lewis, and inferred from his observations that the ice passed from sea to sea across the whole breadth of this district, and that it not only did not come from the mountainous tract to the south, but must have been of sufficient thickness to keep on its course towards the north-west undisturbed by the pressure of the glacier masses which must at the same time have filled the glens and valleys of that mountain region. After describing the characters presented by the bottom-till in the northern part of Lewis, the author proceeded to notice those of the lakes, some of which trend north-west and south-east, others north-east and south-west, whilst those of the mountain district follow no particular direction. The lake-basins of the first series he regarded as formed at the same time and by the same agency as the *roches moutonnées* and other marks of glacial action; they are true rock-basins or hollows between parallel banks formed wholly of till, or of till and rock. The N.E. and S.W. lakes coincide in direction precisely with the strike of the gneiss; and the author explained their origin by the deposition of till by the land-ice in passing over the escarpments of the gneiss facing the north-west. The lakes of the mountain district are regarded by the author as all produced by glacial erosion. The author considered that the ice which passed over the northern part of Lewis could only have come from the main land. Referring to the glaciation of Raasay, he showed that the ice-sheet which effected it must have had in the Inner Sound a depth of at least 2700 feet, and taking this as approximately the thickness of the *mer de glace*, which flowed into the Minch, which is only between 50 and 60 fathoms in depth, no part of this ice could have floated, and the mass must have pressed on over the sea-bottom just as if it had been a land surface. Ice coming from Sutherland must have prevented the flow of the Ross-shire ice through the Minch into the North Atlantic, and forced it over the low northern part of Lewis; and the height to which Lewis has been glaciated seems to show that the great ice-sheet continued its progress until it reached the edge of the 100-fathom plateau, 40 or 50 miles beyond the Outer Hebrides, and then gave off its icebergs in the deep waters of the Atlantic.

DISCUSSION.—Prof. Owen corroborated the author's views as to the grand marks of glaciation on the island of Lewis which had come under his personal observation.

5. "Notes on the Glacial Phenomena of the Hebrides." By J. F. Campbell, Esq., F.G.S.

This communication consisted of notes extracted from the author's journal, giving his observations of indications of glacial action in various islands of the group of the Hebrides. Heynish in Tiree is 500 feet high, and has many large perched blocks on its top. These blocks are of gneiss, and the author thought they came from the north-west. The Barra islands are described as rocky, and resembling the hill-tops of a submerged land. All ice-marks found by the author seemed to him to come from the north and west. He thought that the final grinding was given by floating ice when the land was more submerged than at present. At Castle Bay, in Barra, the author observed well-preserved glacial striæ at the sea-level in a direction from N.N.W. The whole island is glaciated and strewn with perched blocks. Glacial indications were also observed in South Uist, Benbecula, and Skye; and the author stated that, on the whole, he was inclined to think that the last glacial period was marine, and that heavy ice came in from the ocean, the local conditions being like those of Labrador. The author regarded most of the lake-basins of the Hebrides as formed by ice-action, and considered that the ice by which those islands were glaciated came from Greenland.

6. "On Fossil Corals from the Eocene Formation of the West Indies." By Prof. P. Martin Duncan, M.B., F.R.S., V.P.G.S.

The author had considered his labours amongst the fossil corals of the West Indian Islands finished, but lately a very fine collection has been sent to him from the University of Upsala, and Mr. P. T. Cleve of Stockholm. The specimens were collected from limestone and coral conglomerates, which are covered by and rest upon volcanic débris and ejectamenta in the island of St. Bartholomew. The species represented there are numerous, and may be divided into:—Group 1, Species not hitherto known; 2, Species with a Cretaceous facies; 3, Species characteristic of the horizons of the Upper Eocene and Oligocene deposits of Europe; 4, Species found also in the Nummulitic deposits of Europe and Scinde; 5, Species belonging to the recent coral fauna; 6, Species referable to genera which belong to the Jurassic and to the Caribbean fauna.

The determination of the forms of the associated Mollusca and Echinodermata permit the following deposits being placed on a general geological horizon,—the limestone and conglomerate of St. Bartholomew, the dark shales beneath the Miocene of Jamaica, the beds of San Fernando, Trinidad. These were probably contemporaneous with the Java deposits, the Eocene of the Hala chain, the great reefs of the Castel Gomberto district, the reefs of Oberberg in Steiermark, and the Oligocene of Western Europe.

The author has already described reef corals from the Lower Cretaceous (Upper Greensand) of Jamaica; and the size of the specimens proves that the reef was exposed to the surf of an open sea. To these reefs succeeded on the same area others in the Eocene time, in the Miocene and Pliocene; and there are modern reefs in the neighbourhood.

The affinities and identities of the fossil forms with those of contemporaneous reefs in Asia and Europe, and the limitation of the species of the existing Caribbean coral fauna, point out the correctness of the views put forth by S. P. Woodward, Carrick Moore, and the author, concerning the upheaval of the isthmus of Panama after the termination of the Miocene period.

7. "Note on the Lignite-deposit of Lal-Lal, Victoria, Australia." By R. Etheridge, Esq., Jun., F.G.S.

The author described this deposit, which is worked at the village of Lal-Lal, south of Mount Bunniyong. A boring towards the centre of the deposit showed about 73 feet of sand, clay, and gravel, 3 feet of fireclay, and 115 feet of lignite. The lignite is an earthy bituminous coal, composed of branches, roots, etc., of coniferous trees. In the mass there are a few thin seams of jet and clay-beds, accompanied by two kinds of resin. The lignite is very poor in carbon. It is almost entirely composed of remains of coniferous plants not now existing in Victoria; and the author considered that it is nearly of the same age as the Lignite deposit of Morrison's Diggings, which has been regarded as Miocene.

The next Meeting of the Society will be held on Wednesday, November 5, 1873.

Geologists' Association.—July 4th. Henry Woodward, Esq., F.R.S., F.G.S., President, in the Chair.—1. "Sketch of the Geology of Northamptonshire." By Samuel Sharp, Esq., F.S.A., F.G.S.

Northamptonshire is situated about midway upon the Great Oolitic and Liassic belt which traverses England from Dorsetshire to Yorkshire. The Lias constitutes the great basal formation of the whole district; the Upper having a maximum thickness of some 200 feet, the Middle or Marlstone 30 feet, and the Lower 650 feet. The Upper Lias abounds with the usual Reptilian, Cephalapodan, and Molluscan remains, with some Crustaceans, including a new form, referable to the *Palæmonidæ*, named *Penæus Sharpii*, Woodward.

Above the Lias repose the interesting series of beds of the Inferior and Great Oolite, which were succinctly described by the author in this sketch, but had been more fully treated of by him in elaborate papers published in the Quarterly Journal of the Geological Society for August, 1870, and May, 1873.

The lowest of these beds is the "Northampton Sand," divided into the Lower and Upper: the former is for the most part ferruginous, yielding the now well-known Northamptonshire iron-ore, of which at the present time above 20,000 tons a week are being excavated, and producing on an average about 40 per cent. of pig-iron. This bed was quarried largely for iron-ore by the Romans in the third and fourth centuries, but its resources had remained dormant until about twenty years ago. The Lower division of the Northampton Sand is abundantly fossiliferous in bands and patches, and contains Corals, *Ammonites*, large *Nautili*, *Belemnites*, *Echinodermata*, *Lamellibranchiata*, and *Gasteropoda*, including many new forms, among which are—*Lima Sharpiana*, Eth., *L. deltoidea*, Eth., *L. Dustonensis*, Eth., *Trigonia Sharpiana*, Lycett, etc. The Upper division consists of a white sand, sometimes intercalated with patches of blue clay, and containing a peculiar plant-bed, consisting of horizontal layers of super-growth overlying a bed of vertical root-perforations. This division exhibits estuarine characteristics, and has been termed by Mr. J. W. Judd, F.G.S., the "Lower Estuarine" series.

Next in an ascending scale is an important formation (only recently defined), consisting of beds of Oolitic and Marly limestones. It attains in Lincolnshire to a thickness of 200 feet, and has hence been designated the "Lincolnshire Limestone." The fossil contents indicate that these beds are Inferior Oolite: they constitute the uppermost group of the Inferior Oolite series in this part of England.

At the base of the Lincolnshire Limestone occurs, at Collyweston, Easton, and some other places, a calcareo-arenaceous band, which upon exposure to frost splits into slates in the planes of its finely-laminated stratification. This slate is of a cream colour; it was in ancient times the prevailing roofing material of a wide district, and has been of late years much used for church work. The slate-band is highly fossiliferous, and has yielded, among new forms, a beautiful winged univalve, *Pterocera Bentleyi*, Mor. and Lyc.; a small lobster, *Pseudophyllia*; and a unique star-fish, *Astropecten Cotteswoldiæ*, var. *Stamfordensis*, Wright. Limestone beds occur above this slate band: the lower being for the most part marly; some bands yielding a pure cream-coloured soft stone, well adapted for fine interior work; others a good rough building-stone, and all lime. Above the marly beds are the beds of the well-known "freestone" quarried at Weldon, Ketton, Casterton, Ancaster, etc. It is from the peculiar texture of this stone that the term "Oolitic" (so inappropriately applied to the great series of formations bearing that name, and which comprise beds presenting various and frequently opposite petrological characteristics) has been derived. The stone is composed entirely of small egg-shaped grains, embedded in a calcareous matrix. A polished section shows that each of these grains consists of a minute siliceous nucleus inclosed in a series of concentric calcareous films. The beds have yielded the characteristic *Terebratula fimbria* of Sowerby. A very shelly band occurs generally above the workable freestone, which was quarried anciently (even in times as remote as the Roman occupation) at Barnack, and hence was called the "Barnack Rag." Many of our most ancient cathedrals and churches were built of this stone, which time has proved to have been most durable; but it has not been quarried for nearly 400 years. From the

Barnack Rag beds the little Inferior Oolite *Rhynchonella spinosa*, Schloth., has been obtained. The beds of the Lincolnshire Limestone are surmounted unconformably by certain beds of the Great Oolite series. The lowest of these consists of a very variable clay, often disposed in thin laminæ, containing sometimes marine and sometimes estuarine or freshwater shells, much wood, and a plant-bed precisely similar to that previously described: it is almost invariably based by a ferruginous band, varying in thickness from six inches to two feet. It has been distinguished as the "Upper Estuarine." The "Great Oolite" Limestone of the district is superimposed upon the clay last named. It consists of a series of variable beds, some very soft, and some crystalline and hard. A band at Alwalton, near Peterborough, takes a good polish, and has been termed "Alwalton Marble." It was used as early as the 13th century for the slender disengaged shafts of the beautiful front of Peterborough Cathedral. Some bands of this limestone abound with fossils, and have yielded, among new forms, two species of a small lobster allied to *Eryma elegans*, Oppel; a species of fish, of which only two examples are known (and these both found at Blisworth), *Pholidophorus Flesheri*, Agassiz; a beautiful small star-fish, having five attenuated and tortuous rays, *Ophiurella Griesbachii*, Wright, from Oundle; a unique fruit, the type of a new genus and species, *Kaidacarpum ooliticum*, Carruthers, etc. Over this limestone is frequently found a clay characterized by the abundant presence of the small *Ostrea sub-rugulosa*, Mor. and Lyc. From this clay, in several localities, have been obtained vertebræ of the colossal *Cetiosaurus*. This clay is in the same sequential position as that at Kirklington, Oxfordshire, whence Professor Phillips obtained the wonderful skeleton of the same Saurian now in the Oxford Museum. It is probably on the same horizon as the Bradford Clay of the West. Above, successively occur the Forest Marble, Cornbrash, and the Oxford Clay, containing the usual fossils; and the last marking the limit upwards of the range of Secondary formations in the county. The high lands of the district are commonly capped with beds of the Boulder-clay or "Glacial Gravels," having the usual varied contents. The valley-gravels abound with large teeth and tusks of elephants, *E. antiquus* and *E. primigenius*, teeth of *Rhinoceros tichorhinus*, bones of *Hippopotamus major*, teeth of *Equus fossilis*, and *E. caballus*, and heads and horns of *Bos primigenius*. A peaty fluviatile bed above the gravel contains at its base numerous remains of the small aboriginal ox (*Bos longifrons*), Red Deer, Horse, Hog, etc. In describing the geological geography of the county, the author stated that the ferruginous beds extend throughout the entire area of the county, with the exception of a small portion at its north-eastern extremity; but they are thickest and probably richest about the middle. The Lincolnshire Limestone occurs only in the Northern division, thinning away near Kettering and Maidwell. The two Estuarine beds are everywhere present when not denuded, coming together after the thinning away of the intervening Lincolnshire Limestone. The Great Oolite Limestone is thickest near Northampton, thinning to the north-east. The overlying Great Oolite Clay is thickest at Houghton, near Northampton, but has frequently been thinned or removed by denudation. The Forest Marble only occurs over a small area near Peterborough. The Cornbrash only in the Northern division of the county, ranging in from Bedfordshire, near Higham Ferrers, capping the high grounds, north of the Nene, near Thrapstone and Oundle, and covering a considerable area near Peterborough. The Oxford Clay caps the southern escarpment of the Nene Valley from near Thrapstone to the vicinity of Peterborough; occurs in considerable patches, in the same elevated position, north of the Nene, in the neighbourhood of Oundle; but only occupies low situations near Peterborough, where it spreads out into the great level of the Fens. High table-land occurs near Naseby, from the watershed of which rise—the Avon, which flows westward, by Warwick and Stratford-on-Avon, to the Severn; the Welland, which flows easterly, by Stamford and Spalding, into the Boston Deeps, marking the northern boundary of the county throughout the greater part of its course; the Nene, which flows by Northampton and Peterborough, and falls into the Boston Deeps near Wisbeach; and the Ise, a tributary of the Welland: the Ouse rises in the Southern division of the county, but attains to no magnitude until it has passed into Bucks and Beds. Many other minor streams are tributaries to these. The intersections of the county by the valleys indicated by these rivers and streams present innumerable escarpments, from which, in consequence of the alternation of pervious and impervious beds, flow the numerous springs for which the county is famous. The author, after remarking upon the mineral wealth of the county, derivable from the formations described, alluded to the recently revived agitation for a search for coal in the district; which he stigmatized as being both delusive and unwise.

2. "On some New Crag Fossils," by Alfred Bell.

The author's observations since his former paper on the Crags was read confirm the views he then expressed as to the divisibility of the English Crags into four divisions, founded on palæontological evidence. He had determined 145 species (some new to the Crags, and some new to particular divisions) in addition to those given in his published lists. After reiterating his opinion that the Belgian *Sables gris* were intermediate in age between the Coralline and the Red Crags, the author described generally the new forms of each division of the Crags.

3. "An Account of the Eruption of Mount Vesuvius of April, 1872," by J. M. Black, Esq., J.P.

In this paper the brief but violent and destructive eruption of last year was described by the author, who had carefully noted the various phenomena that occurred during its continuance. An ascent of the volcano was made by Mr. Black a few days after the eruption, and the form and condition of the crater observed. The principal feature of this eruption was the formation of a rent down the north side of the cone, and extending 800 or 1000 yards into the Atrio del

Cavallo. The lava issuing copiously from this enormous fissure flowed through the Fosso de la Vetrana, between the extremity of Monte Somma and the Observatory, into the cultivated country, and partly destroyed the villages of Massa di Somma and San Sebastiano. The author had succeeded in photographing in a most admirable manner various parts of the mountain after the eruption, including the crater itself; and the large series of views so taken were exhibited at the Meeting.

CORRESPONDENCE.

ON BLOCKY ROCK SURFACES.

Sir,—While very much interested in Mr. Poulett Scrope's article in your last Number "On Blocky Rock Surfaces," I feel bound to state that the explanation there given of the *blocky* structure cannot apply to Scawfell, since the mountain is made up of *bedded* and altered ash, and certainly is not in any sense "the upper portion of a protruded mass which reached its present position in a state of igneo-aqueous liquefaction."

Keswick, *July 9th.* J. Clifton Ward.

PALÆOZOIC ECHINODERMS WITH OVERLAPPING PLATES.

Sir,—In the July Number of the Geological Magazine, Mr. J. Young pointed out the resemblance between the plates of the Carboniferous genus *Archæocidaris*, McCoy, and the new *Calveria hystrix*, W. Thomson. Mr. Young further made some interesting remarks on the Carboniferous fossil.

In addition to *Archæocidaris*, another Palæozoic genus of Echinodermata possesses imbricating plates in its test. I refer to the genus *Lepidechinus*, Hall. In this the ambulacral plates imbricate from below upwards, those of the inter-ambulacral area from above downwards (Hall, Descr. New Sp. Crinoidea, Prelim. Notice. Albany, p. 18). Prof. Hall placed *Lepidechinus* as a subgenus of *Archæocidaris*, a reference which Mr. Young's observations would go some way to bear out. On the other hand, Messrs. Meek and Worthen have observed that only the marginal inter-ambulacral plates of the lower side of the test of *Lepidechinus* carry primary tubercles (Pal. Ill., vol, 2, p. 295), as do the same plates in *Perischodomus*, McCoy. Could it be shown that the latter also had imbricating plates, there would be grounds for the supposition that the two genera were indeed very closely related. *Lepidechinus* occurs in the Burlington Group (Carboniferous).

Edinburgh, *July 9th*, 1873. R. Etheridge, Jun.

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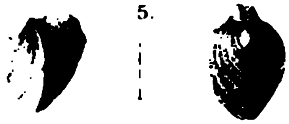

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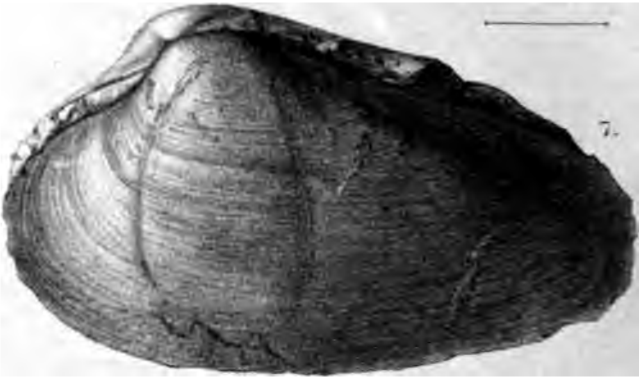

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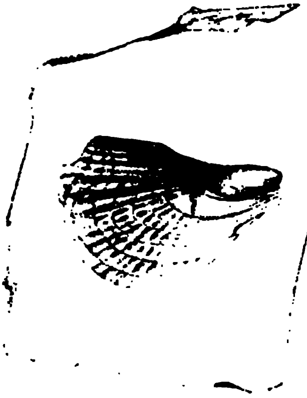

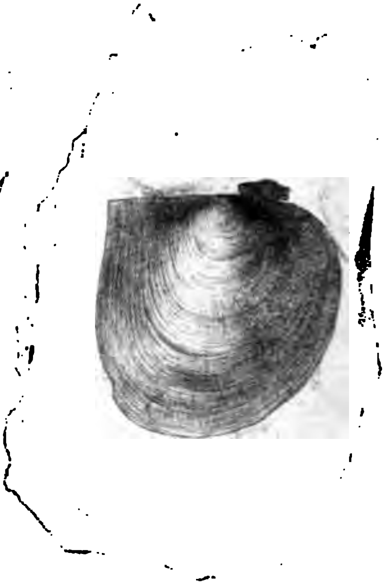

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To illustrate papers by Mr Robert Etheridge Jr.
Contributions to Carboniferous Palæontology.

THE

GEOLOGICAL MAGAZINE.

No. CXI.—SEPTEMBER, 1873.

ORIGINAL ARTICLES.

I.—History of the Names Cambrian and Silurian in Geology.[1]

By Prof. T. Sterry Hunt, LL.D., F.R.S.

IT is proposed in the following pages to give a concise account of the progress of investigation of the lower Palæozoic rocks during the last forty years. The subject may naturally be divided into three parts: 1. The history of Silurian and Upper Cambrian in Great Britain from 1831 to 1854; 2. That of the still more ancient Palæozoic rocks in Scandinavia, Bohemia, and Great Britain up to the present time, including the recognition by Barrande of the so-called primordial Palæozoic fauna; 3. The history of the lower Palæozoic rocks of North America.

1. *Silurian and Upper Cambrian in Great Britain.*—Less than forty years since, the various uncrystalline sedimentary rocks beneath the coal-formation in Great Britain and in Continental Europe were classed together under the common name of graywacke or grauwacké, a term adopted by geologists from German miners, and originally applied to sandstones and other coarse sedimentary deposits, but extended so as to include associated argillites and limestones. Some progress had been made in the study of this great Graywacke formation, as it was called, and organic remains had been described from various parts of it; but to two British geologists was reserved the honour of bringing order out of this hitherto confused group of strata, and establishing on stratigraphical and palæontological grounds a succession and a geological nomenclature. The work of these two investigators was begun independently and simultaneously in different parts of Great Britain. In 1831 and 1832 Sedgwick made a careful section of the rocks of North Wales from the Menai Strait across the range of Snowdon to the Berwyn hills, thus traversing in a south-eastern direction Caernarvon, Denbigh, and Merionethshire. Already, he tells us, he had, in 1831, made out the relations of the Bangor group (including the Llanberris slates and the overlying Harlech grits), and showed that the fossiliferous strata of Snowdon occupy a synclinal, and are stratigraphically several thousand feet above the horizon of the latter. Following up this investigation in 1832, he established the great Merioneth anticlinal, which brings up the lower rocks on the south-east side of Snowdon, and is the key to the structure of North Wales. From these, as a base, he constructed a section along the line already indicated, over Great Arenig to the Bala limestone, the whole forming an ascending series of enormous thickness. This

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[1] Reprinted from the "Canadian Naturalist," new series, vol. vi. no. 3, p. 281.

limestone in the Berwyn hills is overlaid by many thousand feet of strata as we proceed eastward along the line of section, until at length the eastern dip of the strata is exchanged for a westward one, thus giving to the Berwyn chain, like that of Snowdon, a synclinal structure. As a consequence of this, the limestone of Bala re-appears on the eastern side of the Berwyns, underlaid as before by a descending series of slates and porphyries. These results, with sections, were brought before the British Association for the Advancement of Science at its Meeting at Oxford in 1832; but only a brief and imperfect account of the communication of Sedgwick on this occasion appears in the Proceedings of the Association. He did not at this time give any distinctive name to the series of rocks in question. (L. E. and D. Philos. Mag., 1854, IV., vol. viii. p. 495.)

Meanwhile, in the same year, 1831, Murchison began the examination of the rocks on the river Wye, along the southern border of Radnorshire. In the next four years he extended his researches through this and the adjoining counties of Hereford and Salop, distinguishing in this region four separate geological formations, each characterized by peculiar fossils. These formations were moreover traced by him to the south-westward across the counties of Brecon and Caermarthen; thus forming a belt of fossiliferous rocks stretching from near Shrewsbury to the mouth of the river Towey, a distance of about 100 miles along the north-west border of the great Old Red Sandstone formation, as it was then called, of the west of England.

The results of his labours among the rocks of this region for the first three years were set forth by Murchison in two papers presented by him to the Geological Society of London in January, 1834. (Proc. Geol. Soc., vol. ii. p. 11.) The formations were then named as follows in descending order: 1. Ludlow; 2. Wenlock, constituting together an upper group; 3. Caradoc; 4. Llandeilo (or Builth), forming a lower group. The Llandeilo formation, according to him, was underlaid by what he called the Longmynd and Gwastaden rocks. The non-fossiliferous strata of the Longmynd hills in Shropshire were described as rising up to the east from beneath the Llandeilo rocks; and as appearing again in South Wales, at the same geological horizon, at Gwastaden in Breconshire, and to the west of Llandovery in Caermarthenshire; constituting an underlying series of contorted slaty rocks many thousand feet in thickness, and destitute of organic remains. The position of these rocks in South Wales was, however, to the north-west, while the strata of the Longmynd, as we have seen, appear to the east of the fossiliferous formations.

In the *Philosophical Magazine* for July, 1835, Murchison gave to the four formations above named the designation of Silurian, in allusion, as is well known, to the ancient British tribe of the Silures. It now became desirable to find a suitable name for the great inferior series, which, according to Murchison, rose from beneath his lowest Silurian formations to the north-west, and appeared to be widely *spread* in Wales. Knowing that Sedgwick had long been engaged in the study of these rocks, Murchison, as he tells us, urged him to give them a British geographical name. Sedgwick accordingly proposed for this great series of Welsh rocks the appropriate designation of Cambrian, which was at once adopted by Murchison for the strata supposed by him to underlie his Silurian system. (Murchison, Anniv. Address, 1842; Proc. Geol. Soc., vol. iii. p. 641) This was almost simultaneous with the giving of the name of Silurian, for in August, 1835, Sedgwick and Murchison made communications to the British Association at Dublin on Cambrian and Silurian Rocks. These, in the volume of Proceedings (pp. 59, 60), appear as a joint paper, though from the text they would seem to have been separate. Sedgwick then described the Cambrian rocks of North Wales as including three divisions: 1. The Upper Cambrian, which occupies the greater part of the chain of the Berwyns, where, according to him, it was connected with the Llandeilo formation of the Silurian. To the next lower division Sedgwick gave the name of Middle Cambrian, making up all the higher mountains of Caernarvon and Merionethshire, and including the roofing-slates and flagstones of this region. This middle group, according to him, afforded a few organic remains, as at the top of Snowdon. The inferior division, designated as Lower Cambrian, included the crystalline rocks of the south-west coast of Caernarvon and a considerable portion of Anglesea, and consisted of chloritic and micaceous schists, with slaty quartzites and subordinate beds of serpentine and granular limestone; the whole without organic remains.

These crystalline rocks were, however, soon afterwards excluded by him from the Cambrian series, for in 1838 (Proc. Geol. Soc., vol. ii. p. 679) Sedgwick describes further the section from the Menai Strait to the Berwyns, and assigns to the chloritic and micaceous schists of Anglesea and Caernarvon a position inferior to the Cambrian, which he divides into two parts, viz. Lower Cambrian, comprehending the old slate series, up to the Bala limestone beds; and Upper Cambrian, including the Bala beds, and the strata above them in the Berwyn chain, to which he gave the name of the Bala group. The dividing line between the two portions was subsequently extended downwards by Sedgwick to the summit of the Arenig slates and porphyries. The lower division was afterwards subdivided by him into the Bangor group (to which the name of Lower Cambrian was henceforth to be restricted), including the Llanberris roofing-slates and the Harlech grits or Barmouth sandstones; and the Ffestiniog group, which included the Lingula-flags and the succeeding Tremadoc slates.

In the communication of Murchison to the same Dublin meeting, in August, 1835, he repeated the description of the four formations to which he had just given the name of Silurian; which were, in descending order, Ludlow and Wenlock (Upper Silurian), and Caradoc and Llandeilo (Lower Silurian). The latter formation was then declared by Murchison to constitute the base of the Silurian system, and to offer in many places in South Wales distinct passages to the underlying slaty rocks, which were, according to him, the Upper Cambrian of Sedgwick.

Meanwhile, to go back to 1834, we find that after Murchison had, in his communication to the Geological Society, defined the relation of his Llandeilo formation to the underlying slaty series, but before the names of Silurian and Cambrian had been given to these respectively, Sedgwick and Murchison visited together the principal sections of these rocks from Caermarthenshire to Denbighshire. The greater part of this region was then unknown to Sedgwick, but had been already studied by Murchison, who interpreted the sections to his companion in conformity with the scheme already given; according to which the beds of the Llandeilo were underlaid by the slaty rocks which appear along their north-western border. When, however, they entered the region which had already been examined by Sedgwick, and reached the section on the east side of the Berwyns, the fossiliferous beds of Meifod were at once pronounced by Murchison to be typical Caradoc, while others in the vicinity were regarded as Llandeilo. The beds of Meifod had, on palæontological grounds, been by Sedgwick identified with those of Glyn Ceirog, which are seen to be immediately overlaid by Wenlock rocks. These determinations of Murchison were, as Sedgwick tells us, accepted by him with great reluctance, inasmuch as they involved the upper part of his Cambrian section in most perplexing difficulties. When, however, they crossed together the Berwyn chain to Bala, the limestones in this locality were found to contain fossils nearly agreeing with those of the so-called Caradoc of Meifod. The examination of the section here presented showed, however, that these limestones are overlaid by a series of several thousand feet of strata bearing no resemblance either in fossils or in physical character to the Wenlock formation which overlies the Caradoc beds of Glyn Ceirog. This series was, therefore, by Murchison supposed to be identical with the rocks which in South Wales he had placed beneath the Llandeilo, and he expressly declared that the Bala group could not be brought within the limits of his Silurian system. It may here be added that in 1842 Sedgwick re-examined this region, accompanied by that skilled palæontologist, Salter, confirming the accuracy of his former sections, and showing moreover, by the evidence of fossils, that the beds of Meifod, Glyn Ceirog and Bala are very nearly on one parallel. Yet, with the evidence of the fossils before him, Murchison, in 1834, placed the first two in his Silurian system, and the last deep down in the Upper Cambrian; and consequently was aware that on palæontological grounds it was impossible to separate the lower portion of his Silurian system from the Upper Cambrian of Sedgwick. (These names are here used for convenience, although we are speaking of a time when they had not been applied to designate the rocks in question.)

This fact was repeatedly insisted upon by Sedgwick, who, in the Syllabus of his Cambridge lectures, published very early in 1837, enumerated the principal genera and species of Upper Cambrian fossils, many of which were by him declared to be the same with those of the Lower Silurian rocks of Murchison. Again, in enumerating in the same Syllabus the characteristic species of the Bala *limestone*, it is added by Sedgwick: "all of which are common to the Lower Silurian system." This was again insisted upon by him in 1838 and 1841. (Proc. Geol. Soc. vol. ii. p. 679; vol. iii. p. 548.) It was not until 1840 that Bowman announced the same conclusion, which was reiterated by Sharpe in 1842. (Ramsay, Mem. Geol. Surv. vol. iii. part 2, p. 6.)

In 1839 Murchison published his *Silurian System*, dedicated to Sedgwick,—a magnificent work in two volumes quarto, with a separate map, numerous sections and figures of fossils. The succession of the Silurian rocks, as there given, was precisely that already set forth by the author in 1834, and again in 1835; being, in descending order, Ludlow and Wenlock, constituting the Upper Silurian, and Caradoc and Llandeilo (including the Lower Llandeilo beds or Stiper-stones), the Lower Silurian. These are underlaid by the Cambrian rocks, into which the Llandeilo was said to offer a transition marked by beds of passage. Murchison, in fact, declared that it was impossible to draw any line of separation either lithological, zoological, or stratigraphical between the base of the Silurian beds (Llandeilo) and the upper portion of the Cambrian,—the whole forming, according to him, in Caermarthenshire, one continuous and conformable series from the Cambrian to the Ludlow. (Silurian System, pages 256, 358.) By Cambrian in this connexion we are to understand only the Upper Cambrian or Bala group of Sedgwick, as appears from the express statement of Murchison, who alludes to the Cambrian of Sedgwick as including all the older slaty rocks of Wales, and as divided into three groups, but proceeds to say that in his present work (the Silurian System) he shall notice only the highest of these three.

Since January, 1834, when Murchison first announced the stratigraphical relations of the lower division of what he afterwards called the Silurian system, the aspect of the case had materially changed. This division was no longer underlaid, both to the east in Shropshire and to the west in Wales, by a great unfossiliferous series. His observations in the vicinity of the Berwyn hills with Sedgwick in 1834, and the subsequently published statements of the latter, had shown that this supposed older series was not without fossils; but on the contrary, in North Wales at least, held a fauna identical with that characterizing the Lower Silurian. Hence the assertion of Murchison, in his *Silurian System*, in 1839, that it was not possible to draw any line of demarcation between them. The position was very embarrassing to the author of the *Silurian System*, and, for the moment, not less so to the discoverer of the Upper Cambrian series. Meanwhile, the latter, as we have seen in 1842, re-examined with Salter his Upper Cambrian sections in North Wales, and satisfied himself of the correctness, both structurally and palæontologically, of his former determinations. Murchison, in his anniversary address as President of the Geological Society in 1842, after recounting, as we have already done, the history of the naming by Sedgwick in 1835 of the Cambrian series, which Murchison supposed to underlie his Silurian system, proceeded as follows: "Nothing precise was then known of the organic contents of this lower or Cambrian system except that *some of* the fossils contained in its upper members in certain prominent localities were published Lower Silurian species. Meanwhile, by adopting the word Cambrian, my friend and myself were certain that whatever might prove to be its zoological distinctions, this great system of slaty rocks being evidently inferior to those zones which had been worked out as Silurian types, no ambiguity could hereafter arise. . . . . . . In regard, however, to a descending zoological order, it still remained to be proved whether there was any type of fossils in the mass of the Cambrian rocks different from those of the Lower Silurian series. If the appeal to nature should be answered in the negative, then it was clear that the Lower Silurian type must be considered the true base of what I had named the Protozoic rocks; but if characteristic new forms were discovered, then would the Cambrian rocks, whose place was so well established in the descending series, have also their own fauna, and the Palæozoic base would necessarily be removed to a lower horizon." If the first of these alternatives should be established, or, in other words, if the fauna of the Cambrian rocks was found to be identical with that of the Lower Silurian, then, in the author's language, "the term Cambrian must cease to be used in zoological classification, it being, in that sense, synonymous with Lower Silurian." That such was the result of Palæontological inquiry, Murchison proceeded to show by repeating the announcements already made by Sedgwick in 1837 and 1838, that the collections made by the latter from the great series of fossiliferous strata in the Berwyns, from Bala, from Snowdon and other Cambrian tracts, were identical with the Lower Silurian forms. These strata, it was said, contain throughout "the same forms of *Orthis* which typify the Lower Silurian rocks." It was farther declared by Murchison in this address, that researches in Germany, Belgium, and Russia led to the conclusion that the "fossiliferous strata characterized by Lower Silurian *Orthidæ* are the oldest beds in which organic life has been detected." (Proc. Geol. Soc., vol. iii. p. 641, et seq.) The Orthids here referred to are, according to Salter, *Orthis calligramma*, Dalm, and its varieties. (Mem. Geol. Survey, vol. iii. part 2, pp. 335—337.)

Meanwhile Sedgwick's views and position began to be misrepresented. In 1842 Mr. Sharpe, after calling attention to the fact that the fossils of the Bala limestone were, as Sedgwick had long before shown, identical with those of Murchison's Lower Silurian, declared that Sedgwick had placed the Upper Cambrian, in which the Bala beds were included, beneath the Silurian, and that this determination had been adopted by Murchison on Sedgwick's authority. (Proc. Geol. Soc. vol. iv. p. 10.) This statement Murchison suffered to pass uncorrected in a complimentary review of Sharpe's paper in his next annual address (1843). In his *Siluria*, 1st edition, page 25 (1854), he speaks of the term Cambrian as applied (in 1835) by Sedgwick and himself "to a vast succession of *fossiliferous* strata containing undescribed fossils, the whole of which were supposed to rise up from beneath well-known Silurian rocks. The Government geologists have shown that this *supposed* order of superposition was erroneous," etc. The italics are the author's. Such language, *coupled* with Mr. Sharpe's assertion noticed above, helped to fix upon Sedgwick the responsibility of Murchison's error. Although the historical sketch, which precedes, clearly shows the real position of Sedgwick in the matter, we may quote farther his own words: 'I have often spoken of the great Upper Cambrian group of North Wales as inferior to the Silurian system, ... on the sole authority of the Lower Silurian sections, and the author's many times repeated explanations of them before they were published. So great was my confidence in his work that I received it as perfectly established truth that his order of superposition was unassailable. . . . I asserted again and again that the Bala limestone was near the base of the so-called Upper Cambrian group. Murchison asserted and illustrated by sections the unvarying fact that his Llandeilo flag was superior to the Upper Cambrian group. There was no difference between us until his Llandeilo sections were proved to be wrong." (Philos. Mag., IV., vol. viii. p. 506.) That there must be a great mistake either in Sedgwick's or in Murchison's sections was evident, and the Government surveyors, while sustaining the correctness of those of Sedgwick, have shown the sections of Murchison to have been completely erroneous.

The first step towards an exposure of the errors of the Silurian sections is, however, due to Sedgwick and McCoy. In order better to understand the present aspect of the question, it will be necessary to state in a few words some of the results which have been arrived at by the Government surveyors in their studies of the rocks in question, as set forth by Ramsay in the Memoirs of the Geological Survey. In the section of the Berwyns, the thin bed of about twenty feet of Bala limestone which (as originally described by Sedgwick) they have found outcropping on both sides of the synclinal chain, is shown to be intercalated in a vast thickness of Caradoc rocks; being overlaid by about 3,300 and underlaid by 4,500 feet of strata belonging to this formation. Beneath these are 4,500 feet additional of beds described as Llandeilo, which rests unconformably upon the Lingula-flags just to the west of Bala; thus making a thickness of over 12,000 feet of strata belonging to the Bala group of Sedgwick. A small portion of rocks referred to the Wenlock formation occupies the synclinal above mentioned. (Memoirs, vol. iii. part 2, pp. 214, 222.) The second member, in ascending order, of the Silurian system, to which the name of Caradoc was given by him in 1839, was originally described by Murchison under the names of the Horderley and May Hill sandstone. The higher portions of the Caradoc were subsequently distinguished by the Government surveyors as the Lower and Upper Llandovery rocks; the latter (constituting the May Hill sandstone, and known also as the *Pentamerus*-beds) being by them regarded as the summit of the Caradoc formation. In 1852, however, Sedgwick and McCoy showed from its fauna that the May Hill sandstone belongs rather to the overlying Wenlock than to the Caradoc formation, and marks a distinct palæontological horizon.

This discovery led the geological surveyors to re-examine the Silurian sections, when it was found by Aveline that there exists in Shropshire a complete and visible want of conformity between the underlying formations and the May Hill sandstone; the latter in some places resting upon the nearly vertical Longmynd rocks, and in others upon the Llandeilo-flags, the Caradoc proper or Bala group, and the Lower Llandovery beds. Again, in South Wales, near Builth, the May Hill sandstone or Upper Llandovery rests upon Lower Llandeilo beds; while at Noeth Grug the overlying formation is traced transgressively from the Lower Llandovery across the Caradoc to the Llandeilo. These important results were soon confirmed by Ramsay and by Sedgwick. (Ibid. vol. iv. p. 236.) The May Hill sandstone often includes, near its base, conglomerate beds made up of the ruins of the older formation. To the north-east, in the typical Silurian country, it is of great thickness and continuity, but gradually thins out to the south-west.

There exists, moreover, another region where not less curious discoveries were made. About forty miles to the eastward of the typical region in South Wales appear some important areas of Silurian rocks. These are the Woolhope beds, appearing through the Old Red Sandstone, and the deposits of Abberley, the Malverns and May Hill, rising along its eastern border, and covered along their eastern base by the newer Mesozoic sandstone. The rocks of these localities were by Murchison in his *Silurian System* described as offering the complete sequence. When however it was found that his Caradoc included two unconformable series, examination showed that there was no representative of the older Caradoc or Bala group in these eastern regions, but that the so-called Caradoc was nothing but the Upper Llandovery or May Hill sandstone. The immediately underlying strata, which Murchison had regarded as Llandeilo, or rather as the beds of passage from Llandeilo to Cambrian, and had compared with the north-west parts of the Caermarthenshire sections (Sil. Sys. p. 416), have since been found to be much more ancient deposits, of Middle Cambrian age, which rest upon the crystalline hypozoic rocks of the Malverns, and are unconformably overlaid by the May Hill sandstone. We shall again revert to this region, which has been carefully studied and described by Prof. John Phillips. (Mem. Geol. Surv., vol. ii. part 1.)

What then was the value and the significance of the Silurian sections of Murchison, when examined in the light of the results of the Government surveyors? The Llandeilo rocks, having throughout the characteristic *Orthis* so much insisted upon by Murchison, were shown to be the base of a great conformable series, and to the eastward, in Shropshire, to rest on the upturned edges of the Longmynd rocks; while westward, near Bala, they overlie unconformably the Lingula-flags, and in the island of Anglesea repose directly upon the ancient crystalline schists. According to the author of the *Silurian System*, there existed beneath the base of the Llandeilo formation a great conformable series of slaty rocks, into which this formation passed, and from which it could not be distinguished either zoologically, stratigraphically, or lithologically. The sequence, determined from what were considered typical sections in the valley of the Towey in Caermarthenshire, as given by Murchison, for several years both before and after the publication of his work, was as *follows*: 1. Cambrian; 2. Llandeilo-flags; 3. Caradoc sandstone;

4. Wenlock and Ludlow beds; 5. Old Red Sandstone; the order being from north-west to south-east. What then were these fossiliferous Cambrian beds underlying the Llandeilo and indistinguishable from it? Sedgwick, with the aid of the Government surveyors, has answered the question in a manner which is well illustrated in his ideal section across the valley of the Towey. The whole of the Bala or Caradoc group rises in undulations to the north-west, while the Llandeilo-flags at its base appear on an anticlinal in the valley, and are succeeded to the south-east by a portion of the Bala. The great mass of this group on the south-east side of the anticlinal is however concealed by the overlapping May Hill sandstone,—the base of the unconformable upper series which includes the Wenlock and Ludlow beds. (Philos. Mag. IV., vol. viii. p. 488.) The section to the south-east, commencing from the Llandeilo-flags on the anticlinal, was made by Murchison the Silurian system, while the great mass of strata on the north-west side of the Llandeilo (which is the complete representative of the Caradoc or Bala beds, partially concealed on the south-west side) was supposed by him to lie beneath the Llandeilo, and was called Cambrian (the Upper Cambrian of Sedgwick). These rocks, with the Llandeilo at their base, were in fact identical with the Bala group studied by the latter in North Wales, and are now clearly traced through all the intermediate distance. This is admitted by Murchison, who says: "The first rectification of this erroneous view was made in 1842, by Prof. Ramsay, who observed that instead of being succeeded by lower rocks to the north and west, the Llandeilo-flags folded over in those directions, and passed under superior strata, charged with fossils which Mr. Salter recognized as well-known types of the Caradoc or Bala beds." (Siluria, 4th ed., p. 57, foot-note.)

The true order of succession in South Wales was in fact: 1, Llandeilo; 2, Cambrian (= Caradoc or Bala); 3, Wenlock and Ludlow; 4, Old Red Sandstone; the Caradoc or Bala beds being repeated on the two sides of the anticlinal, but in great part concealed on the south-east side by the overlapping May Hill or Upper Llandovery rocks. These latter, as has been shown, form the true base of the upper series which, in the Silurian sections, was represented by the Wenlock and Ludlow. Murchison had, by a strange oversight, completely inverted the order of his lower series, and turned the inferior members upside down. In fact, the Llandeilo-flags, instead of being, as he had maintained, superior to the Cambrian (Caradoc or Bala) beds, were really inferior to them, and were only made Silurian by a great mistake. The Caradoc, under different names, was thus made to do duty at two horizons in the Silurian system, both below and above the Llandeilo-flags. Nor was this all, for by another error, as we have seen, the Caradoc in the latter position was made to include the *Pentamerus*-beds of the unconformably overlying series. Thus it clearly appears that with the exception of the relations of the Wenlock and Ludlow beds to each other and to the overlying Old Red Sandstone, which were correctly determined, the Silurian system of Murchison was altogether incorrect, and was moreover based upon a series of stratigraphical mistakes, which are scarcely paralleled in the history of geological investigation.

It was thus that the Lower Silurian was imposed on the scientific world; and we may well ask with Sedgwick, whether geologists "would have accepted the Lower Silurian classification and nomenclature had they known that the physical or sectional evidence upon which it was based had been, from the first, positively misunderstood"? Feeling that his own sections were, as has since been fully established, free from error, Sedgwick naturally thought his name of Upper Cambrian should prevail for the great Bala group. Hence the long and embittered discussion that followed, in which Murchison, in many respects, occupied a position of vantage as against the Cambridge Professor, and finally saw his name of Lower Silurian supplant almost entirely that of Upper Cambrian given by Sedgwick, who had first rightly defined and interpreted the geological relations of the group.

In a paper read before the Geological Society in June, 1843 (Proc. Geol. Soc., vol. iv. pp. 212-223), when the perplexity in which the relations of the Upper Cambrian and Lower Silurian rocks were involved had not been cleared up by the discovery of Murchison's errors in stratigraphy, Sedgwick proposed a compromise, according to which the strata from the Bala limestone to the base of the Wenlock were to take the name of Cambro-Silurian; while that of Silurian should be reserved for the Wenlock and Ludlow beds, and for those below the Bala the name of Cambrian should be retained. The Ffestiniog group (including what were subsequently named the Lingula-flags and the Tremadoc slates) would thus be Upper instead of Middle Cambrian, the original Upper Cambrian being henceforth Cambro-Silurian; it being understood that, wherever the dividing line might be drawn, all the groups above it should be called Cambro-Silurian, and all those below it Cambrian. This compromise was rejected by Murchison, who, in the map accompanying the first edition of his *Siluria*, in 1854, extended the Lower Silurian colour so as to include all but the lowest division of the Cambrian, viz. the Bangor group. When, however, the relations of Upper Cambrian and Silurian were made known by the discoveries of Sedgwick and the Government surveyors, this compromise was seen to be uncalled for, and was withdrawn in 1854 by Sedgwick, who re-claimed the name of Upper Cambrian for his Bala group.

In June, 1843, Sedgwick proposed that the whole of the fossiliferous rocks below the horizon of the Wenlock should be designated Protozoic, and on the 29th of November, 1843, presented to the Geological Society an elaborate paper on the Older Palæozoic (Protozoic) Rocks of North Wales, with a coloured geological map. This paper, which embodied the results of the researches of Sedgwick and Salter, was not, however, published at length; but an abstract of it was prepared by Mr. Warburton, then President of the Society, with a reduced copy of the map. (Proc. Geol. Soc., vol. iv. pp 212, 251-268; also Geol. Journ., vol. i. pp. 5-22.) In this map of Sedgwick's three divisions were established, viz., the hypozoic crystalline schists of Caernarvonshire, the "Protozoic," and the "*Silurian*." On the egend of the reduced map, as published by the Geological Society, hese latter names were altered so as to read "*Lower Silurian* (*Pro-ozoic*)" and "*Upper Silurian*." These changes, in conformity with he nomenclature of Murchison, were, it is unnecessary to say, made without the knowledge of Sedgwick, who did not inspect the reduced and altered map until it was appealed to as an evidence that he had abandoned his former ground, and had recognized the equivalency of the whole of his Cambrian with the Lower Silurian of Murchison. The reader will sympathize with the indignation with which Sedgwick declares that his map was "most unwarrantably tampered with," and will, moreover, learn with surprise, that an inspection of he proof-sheets of Warburton's abstract of Sedgwick's paper was efused him, notwithstanding his repeated solicitations. The story of all this, and finally of the refusal to print in the pages of the Geological Journal the reclamations of the venerable and aggrieved author, make altogether a painful chapter, which will be found in he Philos. Magazine for 1854 (IV., vol. viii. pp. 301-317, 359-370, and 483-506), and more fully in the Synopsis of British Palæozoic Rocks, which forms the introduction to McCoy's British Palæozoic Fossils. (See also Preface to Salter's Catalogue, just published, 1873.)

In connexion with this history, it may be mentioned that in March, 1845, Sedgwick presented to the Geological Society a paper on the Comparative Classification of the Fossiliferous Rocks of North Wales and those of Cumberland, Westmore-and, and Lancashire; which appears also in abstract in the ame volume of the Geological Journal that contains the abstract of the essay and the map just referred to. (vol. i. p. 442.) That this abstract also is made by another than the author is evident from such an expression as "the author's opinion seems to be grounded on the following facts," etc. (p. 448), and from the manner in which he terms Lower and Upper Silurian are applied to certain fossilferous rocks in Cumberland. Yet the words of this abstract are quoted with emphasis in Siluria (1st ed., p. 147) as if they were Sedgwick's own language recognizing Murchison's Silurian nomenclature.

(*To be continued in our next number.*)

I.—ON THE OCCURRENCE OF SILICEOUS NODULAR BROWN HÆMATITE (GÖTHITE), IN THE CARBONIFEROUS LIMESTONE BEDS NEAR COOKSTOWN, CO. TYRONE; AND NOTE ON ITS FORMATION BY CHEMICAL ALTERATION FROM ORDINARY CLAY-IRONSTONE. WITH ANALYSIS.[1]

By EDWARD T. HARDMAN, F.R.G.S.I.; of the Geological Survey of Ireland;
Associate of the Royal College of Science, Dublin.

THE ore which is the subject of this paper occurs in rather an uncommon manner; its existence, however, has been known or a very considerable period, and it is said to have been worked at east 250 years ago. I believe it is this that is referred to in Dr. Boate's quaint work, "Ireland's Naturell History,"[2] as being found "by the side of the rivulet Lishan, not far from Lough Neagh,"—although he classes it with the ordinary clay-ironstones, which it certainly does not resemble either in composition or appearance.[1]

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[1] Read before the Royal Geological Society of Ireland, May 14th, 1873.
[2] Published in 1652.

It is found at a place called Cove Bridge, near Lissan, in the townlands of Unagh and Tullycall, about two miles north-west of Cookstown. Here there are numerous traces of old workings, and in the rivulet which separates the townlands, as well as in various quarries and rock exposures hard by, sufficient evidence is to be had to enable one to determine with tolerable exactness the position and mode of occurrence of this singular deposit. The section shows a succession of beds of coarse and fine, yellow, purple, and reddish sandstones and grits,—passing into quartzose conglomerate,—interstratified with variously-coloured sandy and clayey ferruginous shales, and several limestones, marbly and dolomitic, closely resembling some of the Armagh beds. In the shales are hollow nodules of hæmatite, sometimes very sparingly distributed, but in at least one bed very abundant. This bed, I am informed by the men who had proved it,—for it does not appear at surface,—is 4 ft. 6 in. thick, the shale, which is itself highly ferruginous, being crammed with nodules, and it has been worked to some little extent. Two pits were opened on it about eighteen months ago; but, as in all mines of this kind, they were found difficult to keep in order, and therefore dangerous to work, and the miners took fright and gave up the attempt.

The following is a section of the strata in which the ore lies, compiled partly from information and partly from my own observation, commencing at the top with the beds passed through in the pits above referred to. (See Sketch Section, p. 401.)

SECTION NEAR COVE BRIDGE.

			Feet	in.
	11	Drift, etc., and Shale (a couple of feet thick) with some hæmatite nodules } about	55	0
Probably Lower Carboniferous Beds.	10			
	9	Coarse rotten sandstone	3	0
	·8	Red clayey ferruginous shale, full of hæmatite nodules. (Workable bed.)	4	6
	7	Whitish sandstone, about	2	0
	6	Hard reddish quartzose conglomerate (calcareous)	1	6
	5	Rotten yellow decomposed clayey sandstone	2	0
	4	Reddish shale, with hæmatite nodules	1	0
	3	Yellow and brown sandy clay, with occasional hæmatite nodules	2	0
	2	Purple, grey, and marbly massive limestone	8	0
	1	White, yellow, and purple coarse grits and sandstones, streaked. Thickness not seen		
			79	0

It is probable that over these, other workahle beds of ore must exist, because the mass of old workings are some distance to the dip his place, and it is not at all likely that the ancient miners ıld venture to a depth sufficient to catch the 4 ft. 6 in. seam there. 'he above section is only approximately correct, as the junction ome of the beds is not visible. The relative position of the ta can, however, be distinctly traced, and the interstratification he ore-filled shales fully made out. They do not, like others of kind, lie in veins, pockets, or erosions in the limestone. In one e, indeed, there is a slight depression in the limestone under the e, but it is difficult to say whether it is due to erosion or to a ll fault.

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[1] It is also referred to by Sir Richard Griffith in his Catalogue of Fossil and Mining Localities, Journ. Geol. Soc. Dublin, vol. ix., and its position marked on his Map; and it is mentioned in Portlock's "Geological Report on Londonderry," etc.; *but, so far as* I am aware, has never been described before.

he nodules are mineralogically very peculiar. They are usually he form of a hollow shell, of, say, a quarter inch in thickness. greater part of this is made up of a very hard compact siliceous wn hæmatite, of a dark brown colour, but the interior is covered ı a thin coating of fibrous and mammillated limonite (Fig. 2 *b*). en they are found *in sitû*, and perfect, they often contain a kind ucleus of sandy shale or clay. (See Woodcut, p. 401.)

he shale in which they occur is generally ochreous red, and seems e highly ferruginous. Being apparently very aluminous, as as in parts calcareous, it might be advantageously used as a for the ore were it worked. In this way the whole bed might ıaps be utilized.

hat the ore is of excellent quality for the smelter will be perceived ı the following analysis. The specimens used were taken at lom from a large heap left after the new workings were disinued, and were not the very best,* for those had been taken y before, and Dr. Ritchie, of Belfast, informed me that some he estimated yielded over 60 per cent. of iron.

ANALYSIS OF ORE.

3	74·56	H_2O (Hygroscopic)	2·90
	a trace	MnO_2	a trace
	0·044	CO_2	a trace
	a trace	P_2O_5	a trace
etc.	9·42†		
3	3·51		100·674
(combined)	10·24	Metallic Iron = 52·20	

his seems to give the composition of Göthite, $Fe_2H_2O_4$,‡—a ahydrate which is a usual form of brown hæmatite,—together with drous silicate of alumina, such as Kaolin, and some free silica. ight be nearly represented by the formula—

$$\underset{\text{Göthite.}}{14Fe_2H_2O_4} + \underset{\text{Kaolin or Clay.}}{Al_2Si_2O_7 2H_2O} + \underset{\text{Silica.}}{2SiO_2}.$$

here was a total absence of sulphur, and the merest trace of ıphoric acid could only be detected by the most delicate test: the ore is extremely well suited for the manufacture of Bessemer . For a brown hæmatite the per-centage of iron is very high; from its composition it seems to be well adapted for admixture

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I found even better specimens, in appearance, in the thin shale-beds.

Soluble silica, together with the insoluble residue, containing a little alumina.

Manual of Geology (Jukes and Geikie), p. 63.

with clay-ironstones, or with the aluminous ore of Antrim. As to its extent, it may run for a considerable distance to the south-east; and if the thickness and richness hold good, it may prove to be a very valuable deposit.

By the kind permission of Prof. Galloway the analysis was made in the Laboratory of the Royal College of Science, Dublin.

It appears to be a circumstance of some novelty to find an ore of this kind as a bed, or part of a bed, in the Carboniferous Limestone, and interstratified with the rocks of that formation. In the North of England, where very extensive deposits of red and brown hæmatite are worked in the limestone, their true mode of occurrence is very doubtful, and for the most part it is believed that they either lie in cavities of erosion in the limestone, or in veins and lodes.[1] In the Alston Moor district, however, brown iron ore occurs associated with the beds of clay-ironstone lying between the "Great" and "Little" Limestones, but it is considered to have some relation to the veins which traverse the country;[2] and although at Cleator, in the Whitehaven district, red hæmatite is found apparently interbedded with shale and conglomerate, this seems to be thought by no means proved.[3] In at least one locality in England hæmatite has been found unmistakably interbedded with the Carboniferous rocks. Its position is given in a section of part of the Old Red Sandstone and Carboniferous Rocks of Lower Purlieu, Forest of Dean, Gloucestershire, in Sir Henry De la Beche's Memoir on the Formation of Rocks in South Wales and South-Western England.[4] The section is chiefly made up of sandstones, shales, and limestones, like that at Cookstown, and, massed together, is as follows:—

	Feet.
Sandstones and Shales	88
Limestone	90
Limestone with intermingled hæmatite, extensively worked... ...	60
Limestone	330

Sir H. De la Beche considers the occurrence of the ore, in beds, very unusual in the Carboniferous Limestone.

The above account, however, does not state in what form the hæmatite is found, whether in nodules, or amorphous or crystalline layers, and in fact in only two instances can I discover any definite account of an iron ore existing in any quantity in the form under notice. It appears that in the Lower Greensand at Seend, near Devizes, and also in Buckinghamshire, nodules of limonite, often hollow, and filled with white sand, are found in thick brown sand. The composition of that at Seend somewhat resembles that of the Cookstown ore.[5]

A similar ore occurs associated with the clay-ironstones of the Dungannon Coal-field, and in its analysis[6] as given by Sir Robert

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[1] Iron Ores of Great Britain, part i. p. 14, W. W. Smyth (Mems. Geol. Surv. of Gt. Brit.).

[2] Iron Ores of Great Britain, part i. pp. 14–17.

[3] *Op cit.* pp. 20–23.

[4] Memoirs Geol. Surv. Great Britain, vol. i. pp. 128–130.

[5] Bauerman's Metallurgy of Iron, p. 76. Contains very little alumina, but much silica.

Kane,[1]—who says that it has been found in abundance—the resemblance is very close. A specimen I picked up at an old pit there was extremely like it, containing also a sandy nucleus; but after many searches I was unable to find any others.

This brings us to one of the most interesting points about the ore, namely, the mode of its formation. I believe it may be considered a kind of pseudomorphic product, the result of the chemical action of water carrying various substances in solution, on nodules of clay-ironstone, the former occupants of these shale-beds; and in order to arrive at the present state of the mineral, we must understand three distinct processes to have taken place. The clay-ironstone nodules, of which numbers are found in the shales of the Carboniferous rocks of the district, were first formed in the usual way by segregation of the highly ferruginous particles of the clays, etc., in which they occur. Then, in the course of time, water passing through the diversely constituted rocks overhead, and therefore taking up alkaline silicates, carbonic acid, bicarbonate or hydrate of lime, sulphate of lime, and of course carrying oxygen, would gradually, by a long series of rather complex decompositions, completely or in part alter the clay-ironstone.

The carbonate of iron might undergo alteration by several re-actions, the simplest of which would be by the direct effect of oxygen, thus:—

$$\underset{\text{Carbonate of Iron.}}{4FeCO_3} + \underset{\text{Water.}}{2H_2O} + \underset{\text{Oxygen.}}{O_2} = \underset{\text{Göthite.}}{2Fe_2H_2O_4} + \underset{\text{Carbonic Acid.}}{4CO_2}$$

And the carbonic acid thus set free would no doubt re-act on a portion of the proto-silicate of iron also contained in clay-ironstone, producing a fresh supply of carbonate of iron, to be again decomposed, as in the above equation:—

$$\underset{\text{Proto-silicate of Iron.}}{Fe''_2SiO_4} + \underset{\text{Carbonic Acid.}}{2CO_2} = \underset{\text{Carbonate of Iron.}}{2FeCO_3} + \underset{\text{Silica (free).}}{SiO_2}{}^{*}$$

By another series of re-actions the clay or silicates of alumina would be decomposed, but would be carried off in solution. The removal of these substances may be accounted for in several ways.

(1). Silicates of alumina are decomposed by sulphate of lime, forming sulphate of alumina—which is soluble—and silicate of lime:†

$$\underset{\text{Kaolin or Clay.}}{4(Al_2Si_2O_7,2H_2O)} + \underset{\substack{\text{Sulphate}\\\text{of Lime.}}}{6CaSO_4} = \underset{\substack{\text{Sulphate}\\\text{of Alumina.}}}{2Al_2(SO_4)^3} +{}^{\ddagger} \underset{\substack{\text{A double Silicate}\\\text{of Lime and Alumina}\\\text{on Garnet type.}}}{Ca_6Al_4(SiO_4)^6} + \underset{\text{Water.}}{8H_2O} + \underset{\text{Silica.}}{SiO_2}$$

The silicate of lime would then be decomposed by carbonic acid,§

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[1] "Industrial Resources of Ireland," p. 129.

* See Bischof's Chem. Geol., vol. ii. pp. 59 and 61. A similar re-action is given in vol. i. p. 2, solid silicate of lime in water containing carbonic acid gives carbonate of lime and free silica. The equation is my own—

$$\underset{\text{Silicate of Lime.}}{Ca_2SiO_4\ (?)} + \underset{\text{Carbonic Acid.}}{2CO_2} = \underset{\text{Carbonate of Lime.}}{2CaCO_3} + \underset{\text{Silica.}}{SiO_2}$$

† Bischof's Chem. Geol., vol. ii. p. 68.

‡ This formula is merely intended to represent graphically what might take place, but by no means to assert the constitution of the body formed.

§ Also by alkaline carbonates, by which the silica as well would be removed.

carbonate of lime being formed as already shown (see note *antè*), and would be carried off by the acid water.

(2). When alkaline silicates are allowed to act on silicates of alumina, they extract minute quantities of alumina; and silicate of soda possesses this property to a very sensible degree: moreover, the alkaline silicates dissolve small portions of the silicate of alumina itself.[1] Thus in time a considerable quantity of alumina might be removed.

Now all these are solutions we should expect to find in the vicinity of strata made up of calcareous and arenaceous rocks. It is of course well known that the water of limestone districts often contains a large amount of sulphate of lime, to which is due what is called its "permanent hardness"; on the other hand, the solution of alkaline silicates may result from the action first of carbonic acid on minerals containing them, and then the subsequent re-action of the alkaline carbonates so obtained on silicate of lime.

By these agencies then, (1) and (2), the silicates of alumina forming the clay must have been for the most part extracted. It will be hardly necessary to remark that carbonic acid would have no direct effect on them, as it does not combine at all with aluminium.

Thus the clay-ironstone results in brown hæmatite more or less free from siliceous and clayey particles, according to the extent to which the alteration has been carried. The final process seems to have been the deposition from solution of the thin external layer of pure fibrous hydrate.

While it is thus shown how such a change is theoretically possible, it is satisfactory to obtain undoubted evidence that this metamorphosis of clay-ironstones of various kinds really does take place; and it may, I think, be proved pretty conclusively by the following example.

On the southern shore of Lough Neagh is found a great thickness of beds of—sometimes very arenaceous—pottery clays, with sand, and occasionally beds of lignite, besides concretionary sandstones, and nodules of clay-ironstone. The whole has been correlated with the Bovey Tracey deposit, but is, I believe, of somewhat more recent date. The ironstones are very hard and compact,[2] sometimes of a slightly greenish colour, and seem to consist chiefly of proto-silicate and carbonate of iron; but the outside is often composed of a thick crust of hard, close, siliceous brown hæmatite, evidently the fruit of the chemical alteration of the original nodule. One of them is represented in the accompanying Woodcut (see Fig. 3). The external shell of hæmatite (*b*) is nearly a quarter of an inch thick, and it almost completely incloses the unaltered ironstone, being broken to show the interior. A qualitative examination was made by me of a portion of the unaltered part of one of these nodules with the following result.

It did not effervesce at all with dilute acid; but when powdered, and treated with strong hydrochloric acid, and gently heated, violent

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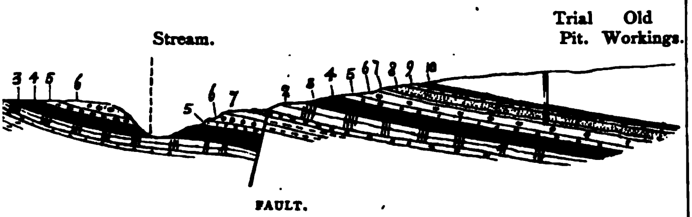
[1] Bischof's Chem. Geol., vol. ii. p. 66.

[2] They contain reed-like plants, still retaining the woody tissue.

FIG. 1.—SKETCH SECTION,

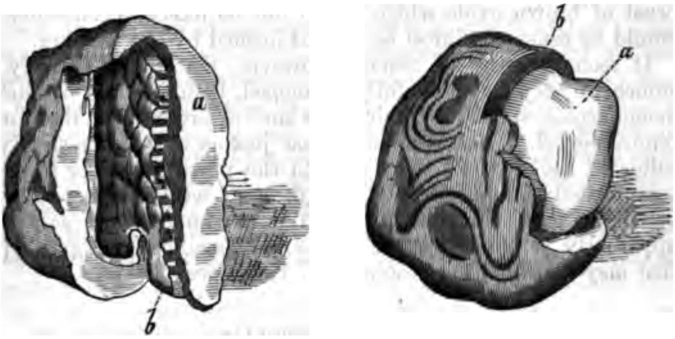
show mode of occurrence of the Hæmatite deposit in the Carboniferous Limestone Beds near Cookstown, Co. Tyrone.



Longitudinal Scale, twelve inches to one mile.
Vertical Scale, about 240 feet to one inch.
Thickness of beds much exaggerated.

(Details of Section will be found at p. 396.)

FIG. 2. FIG. 3.



About half the natural size.

FIG. 2.—Hollow nodule of brown Hæmatite from shale beds near Cookstown.
(*a*) Shell of compact Hæmatite.
(*b*) Internal coating of mammillated fibrous brown Hæmatite.

FIG. 3.—Nodule of Ironstone from later Tertiary beds of Lough Neagh; partially altered.
(*a*) Original Clay-ironstone forming interior nucleus.
(*b*) Shell of pseudomorphic brown Hæmatite consequent on decomposition of (*a*).

action took place, and much carbonic acid was given off. The insoluble residue, consisting chiefly of silica, alumina, and a little protoxide of iron, was not unusually large compared with the bulk taken. The solution contained a very large amount of protoxide of iron, with alumina, and a trace of peroxide of iron. Only a very small trace of lime could be discovered; nothing else was looked for.

Translated for the sake of clearness, this gives—

$SiO_2 + Al_2O_3$ etc.	(insoluble residue).
Fe_2O_3	a trace.
FeO	in large quantity.
Al_2O_3	
CaO	a trace.
CO_2	in large quantity.

It was not considered necessary to make a quantitative examination; for the above could leave no doubt as to the composition of the nodule. It is a clay-ironstone, made up of carbonate of iron, protosilicate of iron, and clay, or silicate of alumina.

These specimens are therefore useful in placing before us the exact method of transformation of clay-ironstone into nodular hæmatite. It is only by the infiltration of water containing oxygen and other chemical agents that these could have been effected, for ordinary atmospheric air could have had no access to them, some of these Tertiary ironstones having been got from beds of clay 20 feet thick, and often covered by from 10 feet to 30 feet of glacial drift. Indeed, the effect of the atmosphere would be merely to form a thin crust of brown oxide which would not be likely to consolidate, but would be removed almost as soon as formed by the weather.[1]

It seems worthy of remark, however, that these Tertiary ironstones are very nearly as fully developed, both in their original and metamorphic stages, as their more ancient brethren of the Carboniferous period. And it appears, that just as we have perfectly consolidated rocks of all ages, so with the power of water to produce complicated changes on all rocks through which it may be able to percolate, even when they are in part composed of constituents apparently so unsusceptible to its influence, or belong to a period that may be called the yesterday of Geological history.

III.—A BRIEF MEMOIR ON THE GEOLOGY OF DORSET.

By J. C. MANSEL-PLEYDELL, F.G.S.

Part I.

THE Geology of Dorset presents an almost consecutive series of formations from the Liassic to the Quaternary. The Rhætic beds which have so large a development in the neighbouring counties of Somerset and Gloucester, just touch the confines of the county near Lyme Regis, and were described by Mr. H.W. Bristow, F.R.S., Director of the Government Geological Survey, at the Bath Meeting of the

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[1] The appearance of clay-ironstones which have been exposed to the weather for a long period is very different from that of any of these; and the thin crust of very incoherent oxide is more highly hydrated, its composition being $Fe_4H_6O_9$.—Manual of Geology (Jukes and Geikie), pp. 15 and 23.

:itish Association in 1864, as everywhere underlying the true ssic strata. They consist chiefly of a central mass of black shale sting on, and passing into, the underlying Keuper marls; whilst eir upper division, which forms the base of the Lias, characterized y the presence of *Ammonites planorbis*, and *Ostrea liassica*, is comsed of beds of marl and marly or argillaceous limestone. Their pper limit is well marked by the White Lias, which, in Mr. Bristow's pinion, forms its uppermost member. The number of fossils from hese beds is considerable, comprising thirty-two genera and fifty-one pecies of shells, six genera and seven species of fish, two reptiles, id one mammal. Of these *Monotis* (*Avicula*) *decussata* is the only ecies common to this and the overlying Liassic formation, although ere is no marked lithological break nor observable unconformity.

LIAS.—The Lower Lias, which is extensively shown at Lyme gis, has been, until recently, massed as an indivisible series of y, shales, and limestones. Palæontologists have now divided it o six zones, each of which is particularly marked by its own oup of fossils, especially by Ammonites: but this grouping has t been found to hold good over large areas. From Devonshire to rkshire the divisions, Upper, Middle, and Lower, are said to be nerally constant, and no actual unconformity is known from the ttom of the Lower to the top of the Upper Lias. The zones thus opted in an ascending order are, 1. *Ammonites planorbis* zone; *Ammonites Bucklandi;* 3. *Ammonites Turneri;* 4. *Ammonites obtusus;* *Ammonites oxynotus*; 6. *Ammonites raricostatus*. The *Ammonites ucklandi* zone attains a thickness of more than eighty feet at Lyme, nsisting of grey limestones, alternating with marls and shales; lower division is characterized by *Ammonites angulatus*, and conins four species of *Ichthyosauri*. The *Ammonites Turneri* zone is aracterized by several species of Cephalopods; an abundance of e Crinoid *Pentacrinus tuberculatus*, and the Saurians *Ichthyosaurus utyodon*, *I. communis*, and *I. intermedius*. The *Ammonites obtusus* ne contains many species which appear for the first time, among iich are *Ammonites planicostatus*, *A. Birchii*, *A. Brookii*, *A. Dudresri*, *Nautilus striatus*, and *Belemnites acutus*. *Extracrinus briareus* longs to the limestone beds of this zone. The *Ammonites raricosus* zone yields several Cephalopods of that family, namely, *nmonites armatus*, *A. nodulosus*, *A. Guibaldianus;* it forms part of e *Hippopodium* bed of Murchison. The beds between this and the *nmonites spinatus* zone inclusive comprise the Middle Lias, which Lyme is upwards of five hundred feet thick; this increased velopment, as compared with the other British representatives of e Middle Lias, occurs, as might be expected, at a point in close oximity to its continental equivalent. At Black Ven and Golden p its lowest beds consist of grey marls, capped in the last-named ality by sand, containing nodules, which appear within twentye feet of the beach-line. At Down Cliff, where a fault lets down e marls, and hides them from view, the downthrow is eastward, out two hundred feet. The Star-fish bed, so called from the *hioderma Egertoni*, belongs to this section, also a band yielding

Ammonites margaritatus. A layer of marl, six feet thick, divides these lower beds of the Middle Lias from about seventy feet of sand, which are in their turn succeeded by ninety feet of Upper Lias clay, near the base of which is a remarkable conglomerate of pebbles, seldom more than an inch in thickness, imbedded in a ferruginous matrix with Oolitic granules. The clays beneath assume more the appearance of the marlstone of other districts. Above this great clay-bed come about 140 feet of brown micaceous sand containing layers of sandstone. Until lately they were named the sands of the Inferior Oolite, but are now generally assigned to the Upper Lias. At Fourfoot Hill, to the east of Eype's Mouth, there is another downthrow of nearly 500 feet, by which the upper beds of the Inferior Oolite are brought below the beach-line. The Lias appears again at Bridport Harbour: also the sands, which attain a thickness of 120 or 130 feet at Burton Bradstock Cliff; further eastward they are covered by beds of Inferior Oolite and Fuller's Earth.

These Midford Sands attain a thickness of 140 feet in the neighbourhood of Sherborne, and are traversed by horizontal layers of indurated sandstone nodules, which rarely contain organic remains. It will be observed from the above account of the Dorsetshire Liassic beds, that they are confined to the south-western corner of the county. The Lias vies with the Oxford and Kimmeridge Clays in palæontological treasures, especially the almost comparatively extinct Saurian and Cephalopod families. With the exception of the Crocodile and the Alligator, the present representatives of the Saurian family are insignificant and harmless; and of the chambered Cephalopods, which probably formed the chief food of their contemporary gigantic reptiles, and had an extensive generic distribution during the Oolitic period, *Nautilus pompilius* is the only existing representative.

The reptiles form a prominent feature of the Liassic formation in a palæontological point of view, the variety and abundance of which have been proved by the exertions of the late Miss Mary Anning and of Mr. J. W. Marder; of these the flying Saurians are the rarest; Dr. Buckland was the first to give evidence of their presence in the Lias. In 1838 Professor Owen obtained a skull with a few other parts of the skeleton of the same or a closely allied species: in March, 1868, Mr. Henry Woodward, when visiting Lyme Regis, secured for the British Museum an entire tail with its bony tendons, $20\frac{1}{4}$ inches in length, closely resembling the tail of *Rhamphorhynchus* from the Solenhofen stone of Bavaria. In August following the Earl of Enniskillen sent up to Professor Owen a slab with the greater part of the bones and head of *Dimorphodon*, having a portion of the caudal series of vertebræ identical with those forming the entire detached tail already obtained;[1] thus establishing the existence of a new generic form—*Dimorphodon*, in addition to *Rhamphorhynchus* and *Pterodactylus* proper. The most distinguishing features of the genus are the association in the same mouth of fish-like teeth, with long lender projecting sharp teeth, with wide intervals, and set in advance, the lower jaw: the disproportionate magnitude of the head is very markable, but which, as Professor Owen remarks, is more completely adapted to combine lightness with strength than the skull of y other known vertebrate or invertebrate animal.

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[1] See Geol. Mag., 1870, Vol. VII. p. 98. Dr. Buckland also observed some of these curious vertebræ in his original specimen of *Dimorphodon* (*Pterodactylus*) *macronyx*, but, strange to say, considered them to be *cervical*.

Inferior Oolite.—The Inferior Oolite limestones and sands, like e Lias, are confined to the north and west portions of the county, tending from Oborne near Sherborne, through Bradford Abbas to erwick; they undergo much dislocation between Wayford and eaminster, and repose on the Upper Lias at their southern bounary, while the northern portion is flanked by the Fuller's Earth. hey have a wide extension between Beaminster and Poorstock; wo successive lateral faults occasion their disappearance at Shipton orge. They occur again at Burton Bradstock, represented by rruginous limestones containing a large per-centage of iron. Dr. Vright divides these beds into three zones, characterized by three rominent Ammonites: 1. *Ammonites Murchisonæ*; 2. *Ammonites umphriesianus*; 3. *Ammonites Parkinsoni.* No. 1 is absent in orsetshire, the result of a thinning out of the bed by which No. 2 brought in conjunction with the Midford Sands. This zone is well epresented at Chideock and Burton Bradstock, consisting of shelly, ron-shot, and brown sandy Oolites: the uppermost contains *Terebraula Phillipsii*; the middle and lower, the characteristic Ammonites; lso *Ammonites Sowerbyi*, *Ammonites concavus*, *Lima Etheridgii*, *Tereratula perovalis*, *Pleurotomaria ornata*, *Pleurotomaria punctata*, etc. he *Parkinsoni* zone is represented at Walditch, Chideock, Burton, nd Sherborne by the upper and lower *Trigonia*-grits; the former ontains the characteristic Ammonite, as well as *Ammonites Martinsii*, *A. Truellii*, *Trigonia signata*—the latter contains *Hyboclypus gibberulus*, *chinobrissus clunicularis.*

Fuller's Earth.—The Fuller's Earth, consisting of marls and lays, spread over the upper beds of the Inferior Oolite, and of a alcareous deposit known as the Fuller's Earth Rock, which forms he middle beds of the series, extends from Oborne to Clifton Wood, where a downthrow brings up the Forest Marble, which covers it as ar as Halstock, where it re-appears, passing through Leigh, and outh Perrott, and thence to Beaminster; it occurs again further outh at Hook Park and Witherston, and disappears in the neighourhood of Shipton Gorge; it finally occupies a very limited area orth of Burton Bradstock. These beds are not very fossiliferous: he most common fossils are *Ostrea acuminata* and *Rhynchonella arians.* The most westerly appearance of the Fuller's Earth is in the cliff at Watton Hill, near Eype, capped by an outlying summit of Forest Marble; it occurs also as the uppermost beds of Burton Cliff. The Fuller's Earth rock is confined to the northern or Vale portion of the county: it is extensively quarried for the lime it contains, and is largely used by the agriculturists as a top-dressing. The clays produce good grass, and support an excellent pasturage.

Forest Marble.—This representative of the Great Oolite consists of blue clays and marls, succeeded by thick layers of stone composed of comminuted shells and sandy slates, to which the name was given by William Smith, in consequence of the large area covered by it in Wychwood Forest. It abounds in ripple and current-marks, from which, and, from the wood it frequently contains, it is inferred that it must have been formed in a shallow sea. In Dorsetshire its lowest portion chiefly consists of clay, with occasional layers of thin fissile and sandy limestone. The soil is generally cold and wet, and is mostly confined to pasturage. The limestone is quarried for flagstones and building materials, and in the neighbourhood of Bridport it is burnt for lime. The upper formation of this series, *Cornbrash*, consists of a loose rubbly, fossiliferous limestone, and is useful for road-making and conversion into lime. The most northern position is Stalbridge, where it attains a breadth of three miles, and takes a southerly direction from Purse Caundle to Holwell, where a fault throws it northward towards Haydon; here it flanks the Honeycombe and Lillington range, passing through North Wootton, Folke, Leweston, to Beer Hackett, where it is again displaced by a fault, and appears once more at Ryme, Yetminster, Melbury Sampford, West Chelborough, to Rampisham, where it is closed in by the Greensand of that district. It occupies a considerable area in the Vale of Bredy, about eight miles long, and five miles broad, bounded on the north by the overhanging escarpment of the Chalk and Greensand, on the south by the sea and Chesil Bank, and on the west by the Inferior Oolite. It also has a considerable extension in the Vale of Weymouth, extending from Langton Herring to Radipole. Owing to the predominance of phosphoric acid and carbonate of lime, the superiority of the Cornbrash over the Forest Marble in an agricultural point of view is well marked. At Puncknoll and Swyre, where the green pastures and brashy arable fields of the northern portion of the parishes are succeeded on the southern side by hard stiff unyielding clays, scarcely repaying the expense of the ploughshare, there is no doubt as to the superiority of the Cornbrash for agricultural purposes. Professor Buckman has presented facts in connexion with the distribution of fossils in the Inferior and Great Oolite beds, showing that twenty-one species of Lamellibranchiate bivalve Mollusca, which are common to the Inferior Oolite and Cornbrash in Gloucestershire, are rare or wanting in the Great Oolite of the district. The recurrence of species he considers to be dependent on the recurrence of similar physical conditions.

Oxford Clay—is a nearly uniform mass of dark clays and shales with occasional beds of argillaceous limestones: the characteristic fossil is *Gryphæa dilatata*. It occupies a more extended area than any of the previous beds, and is not so disturbed by faults; it has an uninterrupted course from Buckhorn Weston, Stalbridge, Lydlinch, Stock, Holnest and Melbury Osmund, about twenty miles in length, and three in breadth. It is flanked on its eastern extension by the Coral Rag at Hilfield, and is overlapped by the Chalk escarpment; its western extremity, lying at the base of Melbury Bubb, being less regular, owing to the dislocation of the subsequent beds. It appears he southern side of the Chalk range at Long Bredy, where it ı a westerly direction to Burton Bradstock, and forms the bed of iver Bredy through the whole of its course. From East Fleet elcombe Regis and Weymouth it forms a belt of low ground, winds round the eastern extremity of the Forest Marble at pole and Lodmore, and from the base of Jordan Hill and Harn about three miles east of Weymouth.

ıRAL RAG.—This series of limestones, clays, sands, and marls lying the Oxford Clay, has received the name of Coral Rag, the r calcareous beds in Wiltshire and Oxfordshire being chiefly ›osed of corals, which are, however, of exceeding rarity in etshire. Its most northern point is Silton, from whence it runs turminster Newton with a breadth not exceeding two miles. [arnhull and Todbere the limestones of this formation make a tiful building-stone; between Haselbury Bryan and Mappowder lt dissevers it by an upthrow of Kimmeridge Clay, and nearly ›unds the Cretaceous outlier of Castle Hill. Its southern exity, in the Vale of Blackmore, is between Hermitage and Hilfield. ›utlier consisting of the lower beds of the series occurs at :shaw. South of the villages of Litton Cheney and Long Bredy row zone of these beds occurs in this very disturbed district, ing upon a parallel bed of Oxford Clay: it again appears at ›n Hill south of Abbotsbury, passing through Broadwey and ın Hill, from whence it forms the coast-line almost without inption to Ringstead Bay. Its most southerly extension is in the ıbourhood of Weymouth, where it is the most Oolitic; it forms ıngle, of which the Nothe and the Fleet at Lynch form the and Smallmouth Sands the apex. The average thickness of the ation here is about 150 feet. It is highly ferruginous, especially e upper beds. At Abbotsbury the Coral Rag is associated with ate of iron, which is as capable of being brought under smelting ment as the corresponding Oolitic beds of Westbury.

IMMERIDGE CLAY.—This lowest member of the Upper Oolite or land beds, universally recognized under this characteristic ›, is so called from a small Dorsetshire village, which, with the ›tion of a range of hills which form the northern boundary, is ted exclusively on this formation. It is composed of a series of and bituminous shales interspersed with several tabular layers :gillaceous limestones, which are brought into a marketable ition in the form of Medina cement. In the vale of Blackmore ms the eastern boundary from the foot of Shaftesbury Hill to path Lane, winding eastward round the base of the indented ı fringe of the confines of this fertile vale. At Buckland ton it meets the great fault which runs north and south from hill near Sherborne to Holcombe and probably to Cerne Abbas; after joining the base of Castle Hill, finally disappears under Greensand about half a mile south of Revel's Inn. At Litton ey it appears to a very limited extent with much dislocation rata, and again at Abbotsbury, continuing eastward through sham, where it flanks the Purbeck beds from Upwey to the east of Sutton Pointz. The southern boundary of this zone is almost a straight line from Abbotsbury to Broadwey, from whence it takes a south-west direction, meeting the coast-line at Osmington Mills; at Ringstead Bay it disappears under the sea-level, its most inland portion being South Holworth. It occupies a small area from the commencement of Smallmouth Sands to the Ferry Bridge, and forms the coast-line from Chesil on the west to Portland Nore and Church Hope Cove on the east of the island. Its most easterly extension is from Gad Cliff to St. Alban's Head. The Kimmeridge Clay of the Vale of Blackmore is less bituminous than that of the Kimmeridge district; where it is upwards of 600 feet thick, and strongly impregnated with bitumen, giving out a disagreeable smell. It burns vividly with a bright and clear flame, but is unfit for ordinary use as fuel; the poor of the neighbourhood, however, use it as a substitute for other fuel. It burns with a cheerful flame, lighting up the chamber, as well as cooking the dinner and boiling the kettle. It has, however, an unpleasant odour when burning, resembling petroleum, and yields a reddish ash. The volatile matter of the richer beds is upwards of 73 per cent.; the solid mineral matter being only 27. The following is the result of the analysis of J. W. Keates, Esq., F.C.S., Consulting Chemist of the City of London Gasworks:

"Nine thousand cubic feet of gas per ton. The lighting power of this gas is equal to 16 candles (sperm), consuming 120 grs. per hour, being burned at the rate of 9·2 cubic feet in a fifteen-holed argand burner. The lighting power of ordinary London gas is 12 candles similar to those mentioned above.

Volatile matter	61	The coke contains—Carbon ...	13·15
Carbon or coke	39	Ash ...	25·85
	100		39·

The ash contains—

Insoluble residue	29·01	Silica	21·75
Peroxide of iron	7·10	Alumina	10·60."

The beds between Chapman's Pool and Gad Cliff are much dislocated by faults which arrest the appearance of the lower beds of the series, otherwise the fossiliferous stratum of Holworth would have succeeded in its proper place instead of being hidden fifteen miles eastward. An anticlinal axis at Kimmeridge Bay is another cause of the retardation of the appearance of the beds in their proper succession. The bands of cement-stone which intercalate the clays and shales facilitate the recognition of the beds, and show, within the space of a mile, their re-appearance no less than six times. At St. Alban's Head and Gad Cliff the upper beds alone are present, the intermediate space (about six miles) displaying not more than one-half of the series. The lowest member of the series is at Ringstead, and, owing to the rock losing its shaly character, the fossils are well preserved. The beds have a northward dip, and are, as already noticed, intersected by numerous faults, causing dislocations, analogous to those of the Coal-measures. The distinctive character of this formation, as compared with the true Carboniferous, is, that the bituminous matter is principally a result of the decomposition of ıal matter. Like the Lias of the western side of the county, it ls a rich supply of Saurian and Cephalopod remains, much im- ;nated with iron pyrites (a compound of iron and sulphur in ›ortion of 45·77 to 54·23), several of which have been figured described by Prof. Owen, F.R.S., and Mr. J. W. Hulke, F.R.S. ɔng the most important is the humerus of a gigantic terrestrial ɜal vying with the Iguanodon and Megatherium in its magni- ı, and of strong crocodilian affinities. Traces of such a gigantic rian have been met with previously in an ungual phalange from Kimmeridge Clay at Ely, and a fibula from Holworth, both of ɔh are in the British Museum. In the Earl of Eldon's collection ìncombe there is a similar humerus.

'uring the year 1871 an entire skeleton of *Ichthyosaurus en- iodon* (Hulke) has been added to our palæontological list, as well he anterior part of the upper jaw of a *Teleosaur*, which is the indication of this genus discovered at Kimmeridge. Before dis- ɜing this part of the subject, it may be stated that the occurrence wo species of *Plesiosaurus* from Kimmeridge have been confirmed Mr. Hulke, *P. brachistospondylus* and *P. Manselii*. The com- son of the limbs of the latter with those of the typical Liassic *ıiosauri* brings out so many and such important differences that and *P. megadeirus* from Haddenham and Ely may well rank as representatives of a very distinct sub-genus.

ɪ addition to the evidence of the proximity of land during the ɪation of the Kimmeridge beds by the remains of the terrestrial *ɔsaur*, a fossil plant, *Pinites depressus*, from the Kimmeridge Clay : Weymouth, has been confirmed and figured by Mr. Carruthers, ..S.

'ORTLAND SAND.—The Portland Sands are about 100 feet thick Purbeck, and from 60 to 80 feet in Portland; they consist of t-grey, soft, siliceous matter, including minute green particles, , like the Liassic sands of the western side of the county, repose n inferior clay-beds; it includes indurated nodules in horizontal ırs, which frequently contain *Trigoniæ* and *Panopeæ*. It meets coast-line between Winspit and St. Alban's Head, and crops out he longitudinal valley from Pier Bottom to Encombe, and from base of the Oolitic range which commences at Encombe and ɪinates at Gad Cliff; the sands re-appear beneath the Portland ıe near Stair Cove, and again at Ringstead; the great Ridgeway t throws them northward, and near Poxwell they take a westerly ction, half encircling the valley of Sutton Pointz on its eastern ı, and forming the base of Chalbury Hill; after a slight inter- tion at Bincombe they continue to the village of Portisham, 'ing Upwey and Friar Waddon on the north.

'ORTLAND STONE.—Here is the first appearance in the West of ;land of the Portland stone, which attains an elevation of nearly feet at Preston and Bincombe, and constitutes a large portion of Isle of Portland. It rises at an angle of nearly 90 degrees on ıorthern side towards Weymouth, with its base upon the Kimmer- › Clay. It skirts the sea-level at Lulworth, and forms a magnificent headland at Gad Cliff, and, pursuing its course eastward, it retires from the coast-line, occupying for the most part the summit of the range behind the village of Kimmeridge. Near Swyre Head a fault throws it northward, and it forms the high land south of the village of Kingston to Downhays Barn, where it takes a southerly direction and touches the coast-line again at Emmets Hill, forming the upper part of St. Alban's Head; through Winspit and Seacombe to Durleston Head, a mile south of Swanage, where the quarries yield a white limestone containing *Ammonites*, *Trigoniæ*, and *Ostreæ;* also tabular veins of chert in large irregular layers and nodules. The oyster-bed is eight feet in thickness, and overlies a series of the freestone beds, which consist of *Ostrea solitaria* cemented together by an infiltration of calcareous matter, and was extensively worked formerly in the old quarries of Tillywhim and Winspit. The beds of the Portland series have a northern dip here, while in Portland they dip to the south. The upper portion, which averages from three to four feet in thickness, is extensively quarried; it contains only casts of fossils—those of a spiral univalve (*Nerinæa*), called by the quarrymen the *Portland screw*, is common. The Roach-bed, as it is locally termed, is very hard and especially adapted for building purposes. A part of old St. Paul's was restored by Inigo Jones from these beds. In the Ridgeway district, especially at Upwey, the Portland Stone assumes a chalky character with chert and *Trigoniæ*—it is associated with the Portland Sands from Poxwell to Portisham.

Purbeck Beds.—A shelly Limestone containing *Ostreæ* occurs among the lower portion of this formation, locally called Purbeck-Portland. A very remarkable bed resting upon a thin band, four inches thick, and crowded with scales of *Histionotus breviceps*, extends over nearly the whole of Portland, the east of Lulworth Cove, Gad Cliff, and Ridgeway, where it is still thinner. Silicified trunks of coniferous trees, which sometimes stand erect, but are generally broken off short, and seldom exceeding eight feet in length, and remains of other plants allied to *Zamia* and *Cycas*, occur in this bed. About a mile to the east of Lulworth Cove there are several dome-like limestone-knobs, hollow in the centre, which are probably the enlarged bases of Cycadean plants. At Gad Cliff, which flanks the western side of Kimmeridge Bay, a large Limestone block, ten feet long and six broad, encases one of these Oolitic trees.

The Purbeck-beds attain their fullest development in Purbeck, and extend from the town of Swanage to Worbarrow, their northern boundary being the valley which unites these two places; their southern boundary the coast to the east of St. Alban's Head, where they turn northward to Afflington Barn, and, skirting the north side of the Encombe and Kimmeridge range to Gad Cliff, are lost beneath the sea at Worbarrow Tout. At Blackmanston they are squeezed up between the Kimmeridge Clay on the south and the Hastings Sands on the north; continuing westward without further expansion, they reappear at Mowps Bay, forming the coast-line to Durdle Door.

The great fault which commences in the neighbourhood of Poxwell, and extends through Friar Waddon to the north of Abbotsbury, has its greatest extension at Bincombe and Ridgeway, where a good section is exposed in the railway-cutting; the Purbeck-beds flank the south side of the fault with a few exceptions from Poxwell to Portisham. The late Prof. Edward Forbes divided them into upper, middle, and lower, each marked by a peculiar assemblage of organic remains; the lower is largely developed at Ridgeway, the middle and upper in Durleston Bay. There are evidences of various changes from sea to brackish-water, and inversely, between each of which long lapses of time must have intervened. The recurrence of the delicate remains and fragments of insects may be accounted for under the supposition that these light spoils from the land were carried down by the rivers into the estuary, and the abundant deposits in some of the beds were probably occasioned by the collapse of insect life, through sudden changes of temperature. Some of the beds at Ridgeway are characterized by a peculiar *Pupa* and a small Hemipterous insect, *Notonecta*, which belonging to an aquatic species may probably be the cause of its being found entire, and not fragmentary, as are the dragon-flies and other entomological remains. At Ridgeway the corresponding beds of the Lower Purbeck differ by a greater development of limestone, and the dark shaly clays are entirely absent, which chiefly constitute the Durleston Bay section. At Durleston Bay the lowest beds commence with the lower insect-beds of Prof. Edward Forbes, and are of marine origin. The quarries which give the Middle Purbecks their valuable economic character lie beneath the Pecten beds, and are chiefly of fresh and brackish water formations. It is from this zone the Fish and Turtle remains are chiefly obtained.

The Cinder bed is the first evidence of the invasion of the sea during the Middle Purbeck age. It is mostly formed of the remains of *Ostrea distorta*, and contains the *Hemicidaris Purbeckensis*, the only Echinoderm of the Purbeck series hitherto known. This bed forms a marked physical feature throughout the island, and by the experienced eye can be detected with certainty. The Cinder bed is succeeded upwards by (H.) Turtle beds, (G.) Pecten beds, (E.) Corbula beds, and (F.) Beef beds, of Rev. J. Austen's list, which are capped by (D.) the uppermost of the Middle Purbeck. The upper division at Swanage is about thirty feet thick, including a band of *Paludina elongata*, which takes a high polish. It was held in high repute by the architects of the middle ages, and there are but few of our cathedrals and old churches which do not contain pillars and window shafts of this material. Mr. Bristow considers there is sufficient evidence that the greatest part of this material for ancient ecclesiastical ornamentation was procured from the neighbourhood of Swanage.

The remainder of the Upper Purbecks consists of a series of bands of clays and stone, the clays being charged with *Cypris* shales, and the stone with *Unionidæ*. At Ridgeway these beds are coarser and more sandy, and contain lignite; at Mewps Bay they are thinner, but contain a greater variety of species of *Cypris* than at Durleston. A remarkable feature in the molluscous fauna of the Purbeck beds is their similarity with those of the fresh-water Tertiary strata, and with existing genera; this resemblance is so great that, with the fossils before us, and no evidence of their geological position, it would be difficult to assign them to a definite geological epoch.

At the commencement of the present century it was generally supposed that the appearance of mammalia was deferred until the Tertiary period, but this delusion was dispelled in the year 1814 by the discovery of the jaw of a small marsupial in the Lower Oolites of the Stonesfield Slate; and, thirty years after, the tooth of another diminutive mammifer *Microlestes* was discovered still further down in the geological series, in the Upper Trias of Stuttgardt. The Upper Trias of Somersetshire subsequently supplied jaws and teeth of two or three marsupial species; although no mammal had up to this time been found between the other members of the Oolitic series and the Tertiary, it was not unreasonable to suppose, that, as abundant proofs existed of plants as well as insects, the balance of life was carried on, as at the present day, by compensating influences, and that *Insectivora* were present then as now to control the undue increase of insect life. The presence of fossil *Mammalia* in the Middle Purbeck was established by the discovery of an insectivorous mammal, *Spalacotherium tricuspidens*, allied to the *Thylacotherium* of the Stonesfield Slate. In the year 1856, Mr. S. H. Beckles, F.R.S., stimulated by these discoveries, proceeded to make a close and systematic search in the fresh-water marl-beds, and with complete success. In three weeks he brought to light, from an area forty feet long by ten wide, and from a layer the average thickness of which was only five inches, several species, many of which were new. They are the subject of an exhaustive memoir by Professor Owen, in the Palæontographical Society's works for the year 1870. No less than eleven genera and twenty-seven species are described and figured; of these the genus *Plagiaulax* has engaged the greatest attention, and has given rise to a controversy as to its being carnivorous or insectivorous. The late Dr. Falconer thought it might be regarded as possessing the type peculiar to the family to which *Hypsiprymnus* belongs, but generically widely distinct from the existing Kangaroo-rat: *Plagiaulax Becklesii* equals the size of a squirrel. Professor Owen on the other hand contends that the demonstration of the carnivorous character of *Plagiaulax* is more ample than that of its having been herbivorous. Small reptilian remains—*Macellodus Brodiei* and *Nothetes destructor*—are found in the feather quarry, (J.) chert beds of Mr. Austen's list.

It is worthy of remark that of the twelve or fourteen species of Purbeck mammalia not one is a member of the orders which are so well represented in the Tertiaries, and all appear to be marsupials allied to Australian groups.

At Durleston Bay and at Ridgeway some of the beds are prolific in insect-remains, especially those of the lower part of the series, consisting, for the most part, of elytra or wing cases of Coleopterous insects interspersed with some Neuropterous wings, and other relics of insect life. These remains consist solely of fragments of wings and a few segments of the abdomen; why the other hard portions of these animals are not mixed up with the rest is a mystery. They were probably the spoils of the land through which the ancient river flowed, by means of occasional overflowings. This is the more probable as the Purbeck series is generally recognized as an estuary deposit.

Amongst the most interesting of the fossils are those of the crustaceous order *Isopoda* (well represented by a single species, the *Archæoniscus Brodiei*, Milne Edw.), which are very rarely met with in the fossil state.

(*To be concluded in our next Number.*)

IV.—On the Glacial Epoch of Great Britain.

By Joshua Wilson.

It must be admitted that if during the Glacial period an arctic current, similar to that which now sweeps along the east coast of North America, were to pass over the submerged portions of our island, there is no reason why the climate of this country should not assimilate to that of Labrador, where there is now perpetual frozen ground in the latitude of Liverpool. The question then is, what evidence have we that such a current existed at the commencement of the Glacial epoch? Have we not the evidence of the striæ on the rocks and mountains of the Scandinavian peninsula, as well as on those of our own country, to show that, during the period of the submergence of these districts, icebergs were driven by an arctic current from the north-east to the south-west?—that the Polar Sea extended from the White Sea to the entrance of the Baltic, spreading southward over Germany to the confines of Switzerland, which can be traced by the deposited boulders and other ice-transported materials? Then, as to the cause of this return current. It must be evident that the Gulf-stream at that date could not have flowed in its present direction. The arctic current coming down the Baltic must have thrown it further to the west, so that in all probability in its northern progress it would impinge on the east coast of Greenland and the Island of Spitzbergen; then being deflected by the polar ice, it would return by the way of the White Sea and the Baltic, so completing the circuit.

As the land was gradually upheaved, we may conclude that in the first instance the larger icebergs would be detained; but there might be a considerable quantity of polar ice transported, until at length there might be only the cold current left. And when, by the upheaval of the land, this was finally stopped, the Gulf-stream would be diverted to its present channel, and by its genial warmth would speedily terminate the Glacial period. The next question is, at what geological date did this change take place? On this I agree with A. Geikie, F.R.S., in his "Scenery of Scotland" (page 320), where he mentions a raised beach, about 40 feet above high-water mark, in which arctic shells have been found, which he considers to have dated from the latter part of the Glacial period. The next upheaval, of about 20 to 25 feet, took place after this island was inhabited and probably covered with forests, showing the amelioration of the climate, as several canoes have been found imbedded in it, which have been hollowed out from large trees.

In order to show that the alteration of the set of the Gulf-stream occurred subsequently to the elevation of the 40 feet beach, I may remark that it is situated on the west coast of Scotland, where it fronts the Atlantic Ocean, and that if the Gulf-stream had impinged on that shore previous to the elevation of this beach, as it now does, nearly at a right angle, it would have been by its off-set under-current swept away into the depths of the ocean. To explain my position, I may refer to what I term the *offshore* current of the onshore gale. It is a well-ascertained fact that the effect of an onshore gale is to give a sea-beach a seaward direction; the cause of this movement we need not go far to seek. If I am not mistaken, Mr. Coode mentions, in his account of the Chesil Bank, that in a heavy south-west gale the level of the water in front of it will be raised three feet above that of the Fleet behind it. This is the result of the friction of the wind on the surface of the water, causing an inshore upper current. This inshore drift must be counterbalanced by an under-current in an opposite direction, a movement similar to a web passing horizontally over two rollers inshore above offshore below. Although this offshore current may not have sufficient velocity to move sand or shingle when at rest upon the beach, yet in union with the back sweep of the wave it will give a preponderating direction seaward to the beach: hence the millions of tons washed down from that bank in a south-west gale, to be returned again next day when the wind has changed to say west-north-west, the Atlantic swell still continuing. An ocean current impinging on a coast at an angle approaching to a right angle will have a similar effect, with this difference—that this action will be constant; hence we must not be surprised that under the influence of the impinging action of the Gulf-stream, the sea-beach is absent. As, for example, we can trace the action of the Gulf-stream from the neighbourhood of Brest to the south-west coast of England as far north as the Bay of Carnarvon in Wales, the south-west and west coasts of Ireland, the west coast of Scotland, to the north of Ireland, the Orkney and Shetland Islands, etc., and the coast of Norway to the north of the latitude of Scotland, as far as the North Cape. It is to be remarked that in Norway to the south of the latitude of Scotland the land is not so deeply indented as to the north, while the warmth of the Gulf-stream is not felt at Christiania; for the winters are colder there than at Bergen, which is so much further north. I may remark how much the west coast of England is incumbered by sands to the north of Anglesea, and also that the shores of the Bay of Biscay are quite sandy in the neighbourhood of Bordeaux, although exposed to the full Atlantic swell. To this action of the Gulf-stream may we not attribute the encroachments of the sea, of which there exist so many traditions as having occurred from the coast of Brittany to the Bay of Carnarvon? I may remark that the west coast of Patagonia presents a not dissimilar coast-line, which may be attributable to a like cause—the impinging action of an ocean current. So we may conclude that if the 40 feet beach mentioned by Mr. Geikie had not been upraised before the Gulf-stream impinged on that coast, it would have been swept down into the depths of the ocean, as I cannot find any traces mentioned of the 20 feet beach where it is not protected by intervening land from the action of the Gulf-stream. On the rising of the land between the White Sea and the Baltic above the sea-level, the return current appears to have been deflected into its present channel by Nova Zembla, then west by the north coast of Iceland, which is now colder than formerly (GEOL. MAG., Vol. VIII. p. 394), down Baffin's Bay, etc,, and it would thus force the Gulf-stream to the southward to its present position.

NOTICES OF MEMOIRS.

I.—PROCEEDINGS OF THE BATH NATURAL HISTORY AND ANTIQUARIAN FIELD CLUB. Vol. II. No. 4. (1873.)

TWO Geological papers are contained in this work:—(1). *Devonian Fossils from the Sandstones on the N.E. of the Quantocks*, by the Rev. H. H. Winwood. The author draws attention to the occurrence of a series of fossils in the dense hard grey sandstones near Holford and Alfoxden, which Mr. Etheridge has determined to be as follows:

Favosites cervicornis.
Petraia celtica?
Atrypa desquamata?
Tentaculites.
Fenestella plebeia.
Actinocrinus.
Plant-remains?

These organic remains determine the beds to belong to the Middle Devonian Sandstones on the same horizon as Hangman, and all the country from Ilfracombe to North Petherton, and corroborate the first impressions which Mr. Winwood formed from his examination of the beds. Further, near Dodington Church, limestone bands, containing *Cyathophyllum cæspitosum*, occupying a higher position than the sandstones of Alfoxden and Holford, were identified by Mr. Winwood as corresponding in time with the calcareous bands or lenticular masses which, in the North Devon area, follow the "Hangman grits" in geological succession.

Having also examined the beds at St. Audries, he considered that they belonged rather to the Middle Devonian than to the Lower Devonian according to Etheridge, or to the true Old Red Sandstone according to Jukes. In the words of Mr. Winwood, we can only add that "there is much yet to be learnt of the geology of these hills."

(2). *The Geographical Position of the Carboniferous Formation in Somersetshire, with Notes on Possible Coal Areas in adjoining Districts of the South of England.* The Somersetshire Coal-field presents many features of great interest, which have been treated of largely by Buckland and Conybeare, G. C. Greenwell, and J. McMurtrie: more recently, an exhaustive memoir on the same subject appeared in the report of the Royal Coal Commission by Mr. Prestwich, assisted by Mr. John Anstie. So much, indeed the greater part, of the workable coal is hidden beneath the newer Secondary rocks, that it is a subject of the highest importance as to the exact limits of the Coal-bearing strata. This question is now discussed by Mr. McMurtrie, who in an accompanying map shows the probable extent of the Coal-measures from Tortworth to the Mendip Hills.

After describing the Coal-measure rocks that appear at the surface in this district, he discusses their range beneath the Secondary strata, and refers briefly to probable coal areas in adjoining districts of the South of England. In regard to the Coal south of the Mendips, he considers it is not unlikely that the southern margin of this supposed basin may show a transition towards the Culm-measures of Devon; but it is equally probable that its northern margin adjoining the Mendips may exhibit the true productive character.

H. B. W.

II.—DESCRIPTION OF A SPECIMEN OF *PTERODACTYLUS MICRONYX*, IN THE TEYLER MUSEUM. By DR. T. C. WINKLER, etc., etc., Conservator of the Teyler Museum, Harlem.

DR. WINKLER has lately given the description of a new example of *Pterodactylus micronyx*, found in the Lithographic Stone of Eichstätt, in Bavaria, and obtained by Oberförster Frederick Spaeth, at Schernfeld, in Bavaria, for the Teyler Museum. The miniature fossil skeleton, which is nearly perfect, with most of the bones in their proper places, lies on its left side on a slab of Lithographic Stone.

The following description is given by Dr. Winkler: Head slightly bird-like. Its total length is 0·035 mill., its height 0·011 mill. The frontal bone is entire, but the others are so hidden in the stone that they cannot be determined. The intermaxillary bone is not straight; as in most of the *Pterodactyles*, there seems to be a small depression towards the middle of the bone, which is 0·017 mill. long. The orbit, in which may be seen the greater part of the sclerotic ring (about 0·001 mill. in breadth), is nearly 0·008 mill. in diameter. Dr. Winkler supposes that this bony ring has slipped from its original place downwards and backwards. There is a cavity in front of the orbit, from which (owing to injury) it is not entirely separated. The nasal aperture is of a triangular form, the apex of the triangle being directed forward. The right ramus of the lower jaw is perfect. It is 0·025 centim. long, and seems to be hollow. The condyle is well seen, and on the upper edge of the bone there is an apophysis slightly elevated and pointed, and with a large base, which Dr. Winkler calls the coronal process. The teeth are small and conical; the upper jaw contains at least eleven, the lower five or six. Their length is about 0·001 mill., and they are enamelled.[1]

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[1] Dr. Winkler says in his description that the teeth extend to the extremity of the jaws; but his drawing seems to show a small edentulous portion in both the upper and lower jaws.

Beneath the lower jaw is the long thin bifurcated hyoid bone, the horns of which are 0·007 mill. in length, and the body of the bone measures 0·004 mill. The neck is curved. The cervical vertebræ are certainly more robust than the dorsal; but these are all too much metamorphosed and mineralized to be accurately described and separately measured. The tail is short, and seems to contain nine or ten vertebræ. Only the debris of the true ribs are seen; they are very thin. As for the false ribs, the author cannot detect a single trace of them, and he agrees with Hermann von Meyer that the parts sometimes taken for those organs are abdominal ribs.

The sternum, coracoid, and scapula are too much hidden to admit of a description. The humerus is more or less curved; its length is 0·018 centim.; the width of the acromial extremity is 0·003 mill., and that of the cubital extremity 0·005 mill. The fore-arm is composed of two long bones, which seem to be anchylosed together. The ulna of the right arm is 0·023 centim. in length; the superior extremity of the right radius is 0·012 mill. in width; all these bones seem to have been hollow.

Near the remains of the fore-arm are seen two small very thin bones, which Dr. Winkler believed to be the bones named "Spannknochen" by the German savants; but after a careful examination, he found them to be the remains of the ossified tendons of the two bones of the left arm, as already noticed in *Pterodactylus Wurtembergicus,* by Quenstedt. The carpal bones are not sufficiently well seen to be described. The slender metacarpal bones are not visible, but we notice the two strong metacarpal bones of the long fingers belonging to either hand. Their length is 0·022 mill., their width in the middle 0·001 mill., and at both extremities 0·0015 mill. Nearly the whole of the fingers of both hands are visible. Of those of the left hand, which reposes on the right, the first has two phalanges; the ungual phalanx still bears the impression of its claw. The second finger has three phalanges. Although the ungual phalanx is nearly entirely hidden in the stone, we can nevertheless recognize its contour and that of the claw. It is doubtful whether the third finger has three or four phalanges.

As for the three small fingers of the right hand, which are under those of the left, it is easy to see that they are exactly similar. The long finger of the right hand is composed of four phalanges; the length of the first is 0·03 cent. The apophysis of the carpal extremity (seen in *Pterodactylus spectabilis*) is not visible in *P. micronyx,* being covered by the matrix. The second phalanx has been lost; but from the impression it has left in the stone, we easily obtain its length, which is 0·025 centim. The third phalanx is separated from the preceding by the femur; its length is 0·02 centim. The fourth phalanx tapers off to a point, without a claw; its length is 0·021 centimetres. The long finger of the left hand agrees with that of the right, but is partly hidden by several other bones. The two femora are complete. That on the right side is quite visible; it is a little curved, it has a length of 0·018 centim. The tibial extremity is expanded. That on the left side is not entirely shown. The tibia is a long hollow bone, of 0·026 centim. in length.

There is no trace of the peronæus. The tarsus is composed of at least three bulbiform bones, and of a bone which has a resemblance to the astragalus.

The feet are quite visible and perfect, with the exception of part of the right foot; they are both in the same position. The metatarsal bones differ in length; the first is 0·008 mill.; the second 0·007 mill.; the third 0·005 mill.; and the fourth 0·0035 mill. The thickness is about the same in all. The first toe shows two phalanges; the second, third, and fourth seem each to have three. On the outside of the left foot, and more confusedly also on that of the right, there is a small organ composed of two short strong phalanges, which the author says cannot be a fifth toe-bone, because it does not possess any metatarsal. Hermann von Meyer calls it the "Stümmel" (or stump).

From the preceding description, it appears that in comparing this specimen with the species of *Pterodactylus* most nearly related to it —viz. *Pt. brevirostris*, *Pt. Meyeri*, *Pt. Kochi*, *Pt. spectabilis*, and *Pt. micronyx*—we find that *Pt. brevirostris* is distinguished from our specimen by its shortness, by the smallness of the cervical vertebræ, the number and dimensions of the phalanges of the feet, and the relative length of the metacarpal bones. *Pt. Meyeri* differs by the length of its fore-arm, which is greater than that of its metacarpus, and we have seen that in the Teyler specimen these two were equal. *Pt. Kochi* presents the same objection as *Pt. Meyeri*. *Pt. spectabilis* shows a longer head, a shorter metacarpus; the long finger is also shorter and thinner, the metacarpus is very different in respect to the relative length of its bones as compared with this specimen. *Pt. micronyx* (Meyer), on the contrary, agrees so closely with it, that Dr. Winkler refers it without hesitation to that species. He also considers that the small size of his specimen indicates that it was not adult, and it is probable that it, like *Pt. brevirostris* and some others, was only the young state of some other species.

REVIEWS.

Researches on Fossil Birds.[1] By M. Alph. Milne Edwards.

THE great work on fossil birds by M. Alph. Milne Edwards is just completed, and in a short paper read to the Academy of Sciences, the author has given the general results to which he has been led by these researches, carried on for twelve years, during which period about twenty thousand bones of birds have been arranged from different strata, yielding nearly 130 new species, besides establishing the characters of the different faunas, from the Cretaceous epoch to the present time.

The new facts recorded have to some extent confirmed the results to which the study of the fossil Mammalia and Reptiles has led, and y have also enabled us to appreciate more fully the physical ıditions of the globe at these remote epochs.

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[1] Abstracted from the Ann. des Sciences Naturelles, 1871, Sér. 5, Zoologie, tom. xvi.

ſL. Edwards infers from the study of the bones found in the recent ›osits of the Mascarines—and which belong to extinct species, as Dodo, Solitaire, Aphanapteryx, Giant Gallinule, Parrots, etc.— t these islands once formed part of a greater extent of land, the ɜrvening portion having been gradually submerged, thus separating m, as Mauritius, Rodriguez, and Bourbon, so that these islands ame the refuge of the last representatives of the terrestrial popuion of more ancient times; but the animals being thus confined in limited a space, and exposed to various destructive agencies, have ‚dually disappeared.

Madagascar was not in immediate connexion with these islands; , when the Europeans first visited them, they did not find mmalia, except some large Bats. None of the Lemuriens, so rerkable and special to the Malagash fauna, exist in the Masines. The study of fossil birds leads to the same result. The three cies of *Æpyornis* that M. A. Grandidier and M. Milne Edwards 'e recognized among the fossils received from the south-west side re enabled them to recognize their affinity to the *Dinornis*, the *tornis*, and *Palapteryx* of New Zealand. All the species belong he same zoological type, and prove that at a more or less remote ch there existed a communication between these lands so distant m one another. Probably a group of islands now submerged ›rded intermediate stations,—of which, however, there is no longer r trace.

n the first age of Man the remains of birds, whether found in 'erns or elsewhere, afford valuable indications of the climatal ıdition of the period. Some of the species have entirely dis›eared, a great number of others have gradually retired northwards. ɜse are the Grouse and the great Snowy Owl, which then re extremely common in the country. Their presence is signifiıt; for if, according to some naturalists, the Reindeer has lived in ınce only since its introduction by the Finnish inhabitants, the ıe explanation cannot apply to birds, which have never been nesticated. There are also found in the caverns a great number species identical with those which now inhabit temperate Europe. ıong others the Domestic Fowl, believed to be originally from lia, but which, on the contrary, has been coeval with the first age Man. The middle Tertiaries have especially afforded a rich lection. Thus, in the Department of the Allier, about 70 species, ɜrred to various groups, have been recognized, some of which do not ong to the present fauna. The Parrots and Trogons inhabited woods; the Edible Swifts built their nests among the rocks, similar hose found at present in certain parts of Asia and the Indian Archiago. A "Secretary-bird" (*Gypogeranus*), closely related to that of Cape of Good Hope, sought, in the plains, the Reptiles which, at s epoch as now, form its natural food. The great Marabout Stork ımingo, and *Palæodus*, birds of singular forms, lived at the same ‚e with the ordinary Wading birds. The Ibis frequented the margins of rivers. where insects and molluscs abounded; the Pelicans swam on the lakes; lastly. the *Gangas* and many Gallinaceæ assisted in giving to this ornithological fauna a very striking physiognomy, which recals the pictures that Livingstone has sketched in certain lakes of South Africa. Some forms were very common in these old Miocene alluvium deposits of Saint-Gerand le Puy, of Vaumas, etc., while others were rare or only represented by a few bones.

The aquatic species are most common, the remains of Ducks being numerous. On the other hand, the Cormorant is found only in certain parts. showing that at this epoch, as at present, these birds were very locally restricted. The small Diver (*Colymboides minutus*) is less abundant than the Sea-gulls, of which two species, *Larus elegans* and *L. totanoides*, were very numerous. It is the same for some of the shore-birds belonging to the genera *Totanus* and *Tringa* (Sandpipers), whilst the *Elorius* and *Himantopus* (Stilt) are represented by few individuals. Numerous bones of Ibis and of *Paleodus ambiguus* are found. The four other species of this genus—*P. gracilipes*, *P. minutus*, *P. crassipes*, *P. goliath*—are far less common.

Portions of the skeleton of the Flamingo, but rarely found entire, occur at St.-Gerand le Puy; while at Cournon and Chaptuzat they are well preserved. Bones of young individuals have been found once at Marabout. Cranes are rare, their bones are nearly always broken, and often gnawed by Rodents, as if they had remained some time on the shore before being imbedded at the bottom of the lake. The Rails, Gallinaceæ, Pigeons, *Gangas*, Passerines, Raptores, and the Parrots have left only few traces of their existence. These birds, from their habits, are not constantly found on the margin of lakes and water-courses; their remains may have been destroyed or devoured in place, and it could be only under exceptional conditions that they might have been carried into lacustrine alluviums. It was only after ten years' exploration of these deposits by M. Milne Edwards that bones of the Parrot, *Ganga*, Secretary-bird, and of Raptores were found; and some, of which remains were long since found, have not again occurred. The majority of these birds appeared not merely to have chosen this district as a passage-station, but (if they did not inhabit it throughout the year) they at least built their nests, as is evident from the fossil eggs, which are found in a perfect state of preservation, and the great mass of bones of young birds, of which the epiphyses were not even anchylosed.

Many Mammalia, belonging to different orders, lived with these birds. The Carnivores, Rodents, Ruminants and Pachyderms were abundant. The *Cainotheria* collected here in numbers, and served as food, not only to the Amphycyon, but also to the small Carnivora which frequented the shores, as the *Lutrictis*, *Plesiogales*, the *Plesictis*, of which there are many species. All the bones of birds from the Miocene strata of Weissenau, in the Mayence basin, present a complete similarity to those from the Department of the Allier.

The ornithological fauna from the celebrated deposit of Sansan, in the Department of Gers, presents another character. None of its representatives are found in the lacustrine deposits of the Bourbonnais and the Limagne; and if the majority of the species belonged to families existing in contemporaneous French fauna, not one is known living, and many present sufficient characters to form distinct genera. A form of Parrot, *Psittacus Lartetianus*, more slender than that of Allier, is one of the most interesting species found in this rich deposit. Gallinaceous birds, of great size, scarcely inferior to the Peacock and true Pheasants, inhabited also the margin of the small lake in which was accumulated the deposits which now constitute the hill of Sansan.

Numerous Passerines, recalling the 'Bengalies' and the 'Senegalies' ("Wax-Bills"), also frequented the water margin. The marine Faluns of the Loire have yielded only a few species of birds. A Cormorant has been recognized nearly as large as that which now lives on our coasts; also a Goose, a little smaller than the Bernacle, a Heron, and a Pheasant.

The beds of gypsum in the vicinity of Paris contain many impressions of the skeletons of birds. These birds are very distinct from the existing forms; and notwithstanding M. Milne Edwards' repugnance to increase the already too numerous generic divisions, he has been obliged to form fresh genera for many of them. Thus the *Cryptornis antiquus* was nearer the *Calaos* than any other known type. The *Laurillardia* and the *Palæogithalus* belong to the Passerines, but are distinguished from all those at present known.

The *Palæortyx* is gallinaceous, and resembles the Quails in form, but is very distinct from these birds; the *Gypsornis* is the giant of the family *Rallidæ*, it nearly attained the size of the Stork; the *Agnopterus* resembles the Flamingoes, although it presents some special characters.

The singular form of these Eocene birds makes us regret our present want of knowledge of those of the Cretaceous period. There are, unfortunately, only a small number of fresh-water deposits of this period. It is then not extraordinary that we have noticed only a few traces of land animals which existed during the accumulation of these thick (chiefly marine) strata. Perhaps in this formation we may yet discover new zoological forms, that may fill up the great gap which exists between the Jurassic *Archæopteryx* and the typical birds of the Tertiary period.—J.M.

REPORTS AND PROCEEDINGS.

I.—Leeds Naturalists' Field Club and Scientific Association.—August 5, 1873.—"The Permian Rocks of the Neighbourhood of Leeds." By Mr. Louis C. Miall, Curator to the Leeds Philosophical and Literary Society. The author first described the base of the Permian system. The Carboniferous rocks, having been disturbed, thrown into anticlinals, and faulted, were greatly denuded, and the Permian rocks were then deposited upon the new surface thus produced. He then considered the conditions of deposit of the Magnesian Limestone. The abundance of mineral salts, exclusive of carbonate of lime, the scantiness of animal life, and the dwarfed state of the Mullusca, all point to deposition in an inland sea or confined basin, similar to the Caspian, Dead Sea, or Great Salt Lake of the present day. During the Triassic period the previous marine surface appears to have become, in part at least, terrestrial or fresh-water. At a much later period the Permian rocks, with others of subsequent formation, were denuded extensively and reduced to the state in which they now occur. The Permian series of the neighbourhood of Leeds were then specially referred to. The Lower New Red Sandstone of South Yorkshire (the Pomfret Rock of Smith) does not appear to be present, at all events in a conspicuous state, in this district. The so-called Lower New Red Sandstone of Plumpton is undoubtedly of Carboniferous age. The Upper and Lower Magnesian Limestone are well displayed. Various sections of these rocks at Rigton, East Keswick, Collingham, Whin Moor, and Knaresborough, were described in the paper. Remarks on the colour of the soil produced by underlying Permian rocks, on the few fossils which have occurred at Garforth and Cold Hill, near Sherburn, and on the superficial drift, concluded the paper.

II.—GEOLOGISTS' ASSOCIATION.

EXCURSION TO HATFIELD, June 28th.—Director: J. Logan Lobley, Esq., F.G.S. After passing through the fine old park of Hatfield, which had been courteously thrown open by the Marquis of Salisbury, and so traversing for a mile the extreme northern edge of the London Tertiary Basin, the party examined the interesting section on the eastern boundary of the park. This exposure shows the Woolwich and Reading beds lying on the Chalk, and capped by the "Basement bed" of the London Clay. The similarities and differences between this and other sections showing Tertiary beds above the Chalk having been pointed out, the members, by a north-western route, proceeded to the cutting on the railway north of Hatfield, where a section nearly half a mile in length exposes the Middle Glacial sands and gravels with a thin overlying sheet of Boulder-clay forming the subsoil of the land. From this place to Hatfield all the railway sections were observed, and the members afterwards returned to London.

EXCURSION TO PLUMSTED AND CROSSNESS, July 5th.—Directors: Mr. Henry Walker, F.G.S., and Mr. F. E. Houghton. A walk over the old river-bed, now the Plumsted Marshes, brought the visitors to the Crossness Works, where an excavation had been made, that the members might see an exposure of the "Forest-bed" and the overlying "Marsh Clay." From the recently opened excavation numerous stools of small trees, chiefly yew and alder, were lying around on the ground. Though these are quite soft, and may be cut like cheese, yet the organic structure is beautifully preserved. At the river-bank Mr. Walker and Mr. W. Whitaker, who were with the party, briefly and generally described the river-valley, after which the members proceeded through the great engine-house to the school-room, where Mr. W. Whitaker delivered a lecture on the Valley Deposits, aided by elaborate sections, which had been prepared by Mr. Houghton. Mr. Whitaker considered the fault running long the base of the hills bounding the valley to be of much older ate than the valley, and that very much had been removed by enudation since the formation of the fault. Subsequently a isit was paid to a well-boring, which had been suspended for some me, but was now about to be resumed. The present bottom of e boring is in the Gault, specimens of which were shown, and it hoped that when this formation is passed through, an abundant pply of good water may be obtained. The members returned by bbey Wood Station to London.

EXCURSION TO THE MALVERN DISTRICT, July 21st, and five followg days.—Directors: Dr. Grindrod, F.G.S.; Rev. W. S. Symonds, A., F.G.S.; and Rev. R. Dixon, M.A., F.G.S.—Monday, July 21.—arly in the afternoon the members, who had arrived from widely eparated parts of England, assembled in Dr. Grindrod's Museum, t Great Malvern, the contents of which were described. The colection is of great value, and consists almost exclusively of Palæozoic ssils, with specimens of the rocks and minerals of the district, and ncludes a case of *Trilobites* which is perhaps unrivalled. The Vorcestershire Beacon was then ascended, and from the summit of his, the highest of the Malverns, the surrounding country, aboundg with geological interest, was surveyed. The ridge of the alverns, composed of metamorphic syenitic rock, and forming robably some of the oldest existing land, extends north and south r about nine miles, with Palæozoic strata on the west, and esozoic on the east. From its crest may be seen the igneous mass f the Wrekin, the Cambrian Longmynds, the Silurian Ludlow proontory-Valley of Woolhope, and elevation of May Hill, the Old ed country of Herefordshire, the Carboniferous Forest of Dean, he Triassic and Liassic Vale of Severn, or "Straits of Malvern," ith, beyond, the Oolitic escarpment of the Cotteswolds. The hysical geology of the Malverns and their surroundings having een described, the party descended the western side of the hills, and t West Malvern examined the "conglomerate of Main Phillips," hich here lies against the Syenite, and then rounding the northern nd of the range, the members reached, by a delightful walk, their emporary home at Great Malvern.—Tuesday, July 22.—On the econd day the train was taken to Ledbury, where the Rev. Mr. ymonds met the party, and at once led the way to an eminence, rom which was obtained a view of the Old Red district to the west, ith Walls Hill, capped by the Cornstones, at about two miles' disance. After listening to a brief lecture at this point, the members roceeded eastwards, and examined sections of Aymestry Limetone, Lower Ludlow, and Wenlock Limestone, containing the usual pecies. Eastnor Park was traversed, with its narrow band of Voolhope Limestone, and broad expansion of Upper Llandovery. s the Volcanic Ragged Stone Hill was approached, an exposure of gneous rock was met with, and shortly afterwards the Holly Bush andstone was seen near the valley of the White-leaved Oak, where r. Symonds provided luncheon for the party. A neighbouring ection of the core of the hill, with its envelope of metamorphic rock, covered by on one side the Holly Bush Sandstone, detained the members for some time, and then the road was taken by Howler's Heath, near which masses of Upper Llandovery Permian breccia and Bunter Sandstone are conspicuously exposed. The Rev. Mr. Hill entertained the party at his rectory of Broomsberrow, and subsequently the road by Clencher's Mill, where Mammalian drift occurs, was followed past Eastnor to Ledbury, whence Malvern was quickly reached by rail.—Wednesday, July 23.—This morning the members drove over the Triassic plain, at the base of the Malverns, to Berrow Church, near which rises the Liassic outlier of Berrow Hill. Exceedingly interesting sections of the Upper Keuper Sandstones, with *Estheria minuta*, and abundant plant-remains, and of the overlying variegated marls. The sandstones were carefully examined, and briefly described, by Mr. Symonds and Mr. J. Plant. At Pendock Rectory the members were most hospitably entertained at luncheon by the Rev. Mr. Symonds, who, after conducting his visitors to the ancient Pendock Church, where Mr. J. Parker, of Oxford, gave an excellent lecture on its archæology, led the way across the Trias to the east, until Pull Court was reached. There the Severn high level drifts, which have yielded remains of *Elephas*, were seen; then the route was continued to the Severn, with its striking section of the Upper Keuper Marls near Tewkesbury, and from this town, in the centre of the "Malvern Straits," the party returned to Malvern.—Thursday, July 24.—The fourth day was devoted to the attentive study of the Valley of Woolhope, under the guidance of the Rev. Mr. Dixon, who conducted the members to the most advantageous points and sections, and aided by maps, enabled all who followed him to master the geology of this remarkable valley. Leaving Stoke Edith station, and crossing the two encircling rims of Aymestry and Wenlock Limestone, and the broad interior band of Woolhope Limestone, the central dome of Upper Llandovery, covered by Haugh Wood, was reached. Descending to Mordiford, the party emerged from the valley at the gorge near that village, and traversing the exterior slope of Old Red along the valley of the Frome, passed through Stoke Edith Park to Tarrington, where a brief visit was paid to the inn used by Murchison while exploring the district. From Stoke Edith the train was taken to Malvern.—Friday, July 25.—Heavy rain detained the members in the museum of Townshend House on the morning of the fifth day; but an opportunity being thus afforded for a re-examination of Dr. Grindrod's collection, the time was by no means unprofitably spent. In the afternoon the hills were crossed by the Wyche Pass, and the Malvern Syenite, with its epidote, carefully examined. At Colwell Copse the Wenlock Limestone is well seen in an extensive quarry, and yields the usual Wenlock species. When the hills were reascended, the Upper Llandovery was found reposing at a high angle against the central ridge of Syenite. Returning to the eastern side of the range, the Bunter Sandstone of the Trias was also seen resting on the Syenite. In the evening a conversazione, in honour of the visit of the Association to Malvern, was held at Townshend

House, which, with its extensive winter promenade and spacious museum, was thrown open to a large company of visitors, to whom the members of the Association described Dr. Grindrod's palæontological treasures. Later in the evening, the Vicar of Malvern in the chair, geological addresses were delivered by Mr. M. Moggridge, F.G.S., of Mentone, and Mr. J. Logan Lobley, Hon. Sec.—Saturday, July 26.—On the morning of the concluding day the Geological Museum in Malvern College was inspected, and afterwards carriages were taken to the Herefordshire Beacon, which was ascended, and its southern extension traversed to Eastnor Park. A lane section, near the Somers Obelisk, of Upper Llandovery, yielding *Ctenodonta Eastnori*, and *Lingulella parallela*, and *L. crumena*, occupied attention for some time; and then skirting Midsummer Hill, exposures of Holly Bush Sandstone and the "Black Shales" were reached and carefully examined. At a boss of igneous rock not far distant, the members took leave of their director, and cordially thanked him for his exertions for the success of the week's proceedings. During the evening the members departed from Malvern for their several homes.

CORRESPONDENCE.

THE SARSEN STONES.

Sir,—I have just read the Rev. J. Adams's paper on "Sarsen Stones," and I think I can throw some light on their origin.

I had seen portions of "Grey Wethers" and of Stonehenge before I left England, and when I lived at St. Germains I remarked in the Museum two whetstones for flint-weapons made of similar fawn-coloured siliceous sandstone. A similar stone is now quarried near the town, and in the quarry I found a detached mass of Pudding-stone, with nodules of flint three by two inches, larger, much larger than any I have seen in the English Pudding-stone. Between St. Germains and Grignon, still within the forests, there is a most extensive quarry of the same stone, which is used, I believe, not only for road metal, but also for millstones, etc. It is there about eight feet thick, without fossils or any lines of stratification or deposit, but it is fissured at intervals perpendicularly, and it is by these fissures that it can be broken up. Its surface is embossed in the most extraordinary manner, or perhaps I should say hollowed out into pits of different depths from nine inches to two feet, the internal portions varying also in depth below the general level, but never running into each other, so that when I saw it, it was full of little pools of water.

I was unable to trace this massive rock in its relation to the Calcaire grossier; but at a short distance I found small blocks imbedded in loose sand of the same colour, containing Cerithia and other Grignon fossils, which I could not distinguish from the mass, and I believe it is from this bed that the shells in the Paris Seine gravel are derived, for similar shells from Calcaire grossier are usually only casts, and are too fragile to bear the friction of the gravel.

Lastly, I found in the raised beach at Brighton, a little piece which I think I showed to you, in comparison with a pebble of dark red sandstone you had obtained from the same deposit, and I mentioned that the one was too light and the other too dark to be the Grés de May, or Caradoc Hartshill, or Lickey Quartzite, or Sandstone.

Instead of returning home from Brighton, I went on to Selsea, and there on the shore I saw several large blocks of the same stone, so this proves that they lay above the London Clay.

This is quite different from the Chalk conglomerate which caps some of our Chalk hills here, and is evidently still in process of formation, by the agglutinating power of the oxide of iron so abundant above the Chalk.

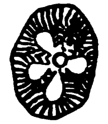
I have never been at Fontainebleau, but I should consider, from its position above the Calcaire grossier, that the St. Germains stone is the same; but though I found the block of pudding-stone lying in the quarry, I never could learn whether it formed a continuous bed, though I asked Mons. Mortillet about it. The French querns are formed from a pudding-stone with small flints, just like the English querns, and are of the same size.

The bit of stone inclosed is from one of the small blocks. The smaller piece is from a Selsea block without fossils.

24, Hyde Gardens, Eastbourne. T. Ogier Ward.

PENTACRINUS PRISCUS, GOLDF., IN THE LOWER DEVONIAN, MEADFOOT SANDS, NEAR TORQUAY.

Sir,—A high authority in the geological world has said, with respect to the Crinoidea, "It is perfectly useless to do anything without the cups," and, probably, this ought to have deterred me from sending you the inclosed rough sketch of a fossil which is found, though somewhat rarely, in the Lower Devonian shales and grits of Meadfoot Sands, near Torquay. The sketch is magnified three diameters, and though only known to us hitherto in the shape of impressions, yet the characters are so very well marked, notwithstanding imperfect specimens hitherto found, that I am tempted to send you a notice of its occurrence, as it has, I believe, been hitherto undescribed from the English Devonian. It is apparently the *Pentacrinites priscus* of Goldfuss, plate liii. fig. 7 *a b*, and the specific characters he gives are very nearly the same as those of our specimens.



Column subpentagonal; joints either all of equal size, or alternately larger and smaller. The joint faces rather hollow, with a rosette of five oval leaves, rather pointed at the extremities (in the impression this rosette slightly projects). The radiating lines somewhat large, but few in number; those *between* the leaves meeting each other in angles, three or four between each pair of leaves; those towards the ends of the leaves going direct to the circumference of the joint.

These fossils have been found hitherto almost exclusively in sandy grit, *not* in limestone; and in nearly every case in the same beds with the *Pleurodictyum problematicum*. As they are only casts or impressions, it is difficult to say whether the joints alternate in size or not; but from an examination of several casts the former is probably the case.

Some other species of *Pentacrinus* have the joint faces ornamented with lines placed somewhat in a similar manner; as, for instance, the *Pentacrinus lævigatus* of the St. Cassian beds (Laube, tab. viii. *a*, fig. 21), and joints are found in the greensand of Chute Farm, with ornamentation of the same kind; but in neither of these cases do the lines meet at such a decided angle between the leaves as in the Devonian specimens.

It will be seen that in the fossil sketched one of the leaves is imperfect.—I remain, &c., JOHN EDWARD LEE.

VILLA SYRACUSA, TORQUAY,
1st August, 1873.

ABSTRACTS OF GEOLOGICAL PAPERS.

SIR,—Any one who has occasion to follow the progress of Chemical Science will readily admit that his labour has been much lightened since the Chemical Society has introduced the plan of publishing monthly abstracts of the more important papers selected from both British and Foreign Journals. It occurs to me that this example, set by the Chemists, might be followed, with great advantage, by the Geologists. The Journal of the Geological Society, it is true, publishes the titles of a great number of papers bearing upon our Science; but a bald list of titles, even if it extend to a complete bibliography, can have but very limited value, and in many cases must be well-nigh useless. Nor would it suffice to follow each title by a notice limited to a few lines, as is done, for example, in the 'Verzeichniss der Anthropologischen Literatur,' which forms an excellent feature in the *Archiv für Anthropologie.* Such short notices have, of course, their measure of value, but would be scarcely full enough to fairly represent the progress of an important science like Geology. Even the publication of an annual volume, similar to *The Zoological Record,* to Delesse and De Lapparent's *Révue de Géologie,* or to Kenngott's *Uebersicht der Resultate Mineralogischer Forschungen,* would be far from satisfactory when compared with the admirable system adopted by the Chemical Society. By means of that system, the English chemist learns, as early as possible, what is going on in each department of his science, and is furnished with abstracts sufficiently full in most cases to put him in possession of the main points in each paper. This, or something akin to this, is just what the geologist needs. Perhaps the student who confines his attention to British Geology may not fully realize the want of such a work as that now advocated; but its value will assuredly be recognized by those who have occasion to spend much time in frequent reference to the Transactions of Foreign Societies. As the British Association deems the publication of the Zoological Record and of the Chemical Society's Abstracts sufficiently important to aid both these works by grants of money, it may be worth while considering—now that we are on the eve of the Bradford Meeting—whether Geology has not equal claims on the funds of the Association.

JERMYN STREET,
August 18, 1873.

F. W. RUDLER.

ON A NEW METHOD OF WRITING CRYSTALLOGRAPHIC FORMULÆ.

SIR,—All mineralogists, or at any rate all whose hard lot it is to be commencing the study of mineralogy, must cordially agree with Mr. Rutley that it "would doubtless be productive of much satisfaction if a universal system of crystallographic notation could be adopted." There is no doubt that the many difficulties with which mineralogy unnecessarily bristles are largely due to confusion, resulting from the conflicts of rival methods of classification and nomenclature, and of different systems of crystallography. I have carefully compared the new method unfolded by Mr. Rutley in the GEOL. MAG. for July (p. 299) with the principal systems now in vogue, and as it does not seem to have merits so pre-eminent as to insure its sweeping all others from the field, it is doubtful whether its partial acceptance will not place one more obstacle in the student's path.

The system of crystallography originated, I believe, by Dr. Whewell, perfected by Professor Miller, and accepted by Professor Haidinger, contrasts more favourably even than that of Naumann, with Mr. Rutley's new method; and I am surprised that no reference is made to it by the author. I question much whether the concise hieroglyphs of Mr. Rutley will be found so easy to imitate as the more accustomed symbols of Naumann, or the plain indices of Miller;—both these have the immense advantage of being already familiar to mathematicians, and without some mathematical skill, extended acquaintance with crystallography is well nigh hopeless. The introduction of this new method, too, involves the replacement of certain known symbols by others hitherto used with different meanings, as well as the alteration in value of some that are retained. Thus the substitution of a dot for the usually accepted sign of infinity is a loss rather than a gain: a dot, in manuscript, generally causes perplexity, which the close neighbourhood of small vertical and horizontal strokes will, in the new method, much intensify.

In the calculations that occur in the more advanced parts of crystallography, the inferiority of the "new method" to that of Professor Miller becomes more and more apparent. We do not suppose that Mr. Rutley intends to limit the application of his system to the mere beginning of crystallographic science;—to assume this would be at once to pronounce the system unprofitable. Professor Miller's indices are perfectly adapted for employment in mathematical investigations, and practical numerical results are at once obtained by simple substitution at the end of such process. But if Mr. Rutley's "prolonged vertical cross" and "curved line" take the place of the "conventional distances m and n," numbers must be substituted for them throughout the calculations, the labour of which is thereby greatly increased; for these difficult signs would undergo a process of natural deterioration in the mazes of hastily, perhaps carelessly, written mathematical analysis, and would, certainly, be illegible at the end of it.

DOWNING COLLEGE, CAMBRIDGE. T. W. DANBY, M.A.

OBITUARY.

On the 29th of May France lost one of its ablest and most dis- guished geologists. Philippe-Eduard Poulletier de Verneuil was rn in Paris on the 13th of February, 1805. He was destined by s parents to become a magistrate, but he preferred to devote all his ne, energy, and fortune to the advancement of the sciences of eology and Palæontology. He began his investigations by an ex- oration of Wales, at a period when Sedgwick and Murchison were ndering that portion of Great Britain classic soil, and this first urney had great influence in determining the future career of ung de Verneuil. On his return from Great Britain he visited urkey and the Crimea, and the results of his expedition will be und recorded in the "Memoirs of the Geological Society of France." . de Verneuil next devoted much attention to the study of the evonian rocks and fossils of the Bas-Boulonnais and Rhenish ovinces; these last he described in conjunction with Viscount Archiac in the fourth volume, second series, of the Transactions of e Geological Society of London.

The three summers of 1840 to 1842 were occupied by M. de erneuil, Sir R. Murchison, and Count Keyserling in an elaborate ploration of Russia and the Oural Mountains, an extent of country ualling half the surface of Europe, which resulted in the pub- ation of the magnificent work known as "Russia and the Ural ountains." This great work was soon followed up by an explor- ion of the United States, which enabled M. de Verneuil to rrelate the Palæozoic rocks of Europe with those of America, a ork of great value and importance. The memoir embracing these vestigations, and many others by the same author, will be found blished in different volumes of the Bulletin of the Geological ciety of France, as well as an account of his numerous and im- rtant explorations and journeys into Spain, executed during the ars 1849 to 1862.

M. de Verneuil was for many years a Member of the Academy Sciences of Paris, as well as a Foreign Member of the Royal ciety of London, and many other scientific bodies in France and sewhere considered it a high honour to have his name upon the list its members. In 1853 he received the Wollaston Medal from e Geological Society of London. His taste for travelling was quite traordinary, he was constantly on the move, visiting every country e after the other, and collecting every fossil upon which he could y his hands; he consequently formed one of the largest and most luable collections of Palæozoic fossils to be seen anywhere, hich he has with great liberality bequeathed to the School of Mines Paris.

M. de Verneuil was eminently what the French would term a *n enfant*, simple in his tastes, always cheerful and ready to assist d to impart information to others, and especially anxious to te down in his pocket-book every scrap of information he could tain from his scientific friends. The joy he used to manifest on the iscovery of some new fossil or geological fact was truly remarkable, and he lost no time in communicating his discoveries to others. M. de Verneuil maintained during forty years a continual scientific intercourse with Sir R. Murchison and Mr. Davidson, for whom he continually expressed the most affectionate feelings and friendship. He was a constant attendant at the Geological Society of France, and rendered that Society the most eminent services. During the last few years of his life his sight was failing him to such an extent that, had he lived a year or two longer, he would, like Lamarck, have been doomed to complete blindness. M. de Verneuil has left a name behind him which will for years be remembered with honour by his numerous geological and palæontological friends.—T.D.

John Wickham Flower, Esq., F.G.S., of Park Hill, Croydon, descended from a Norfolk family, was born in London on the 11th August, 1807. He was educated at a school in Cambridgeshire, where he was well grounded in classical literature, for which he retained a strong love and continued to cultivate throughout life. His special tastes led him, however, to the study of Archæology and Natural History; and his first savings were spent in an excursion to Winchester, to examine the antiquities of that place and the tomb of William of Wykeham. His attention was early directed to Geology, and he spared neither personal trouble nor expense in enlarging his collections, which were always made as much in the general interests of science, and of his friends, as for himself. He closely explored the interesting Tertiary cliffs of Hampshire, and was instrumental in discovering the fine and unique jaw of an alligator at Hordwell. He collected also largely from the Brick-earth beds of Grays. Nor did he neglect the opportunity offered him by the residence of a friend at Moreton Bay, Australia, to procure a very fine series of the land, freshwater, and marine mollusca of that district, many of which were new to this country.

But the particular problem which he set himself to work out, on his settling at Croydon some twenty-five years ago, was to ascertain whether the immense pebble-beds of Addington, belonging to the Lower Tertiary series, were not formed of flints derived from the destruction of higher beds of Chalk than any which now remain in the neighbourhood of London. Stratigraphical Geology has shown that the Chalk formation, as it trends towards the Weald, had been largely planed down before the deposition of the Tertiary Strata, and Mr. Flower's palæontological researches seemed quite in accordance with this view, and to point to the former existence of beds older even than any now remaining in the London Basin. In pursuance of this object, he carried on for years an examination of the flint pebbles forming the Addington Hills, and broke up many thousands of them in search of the small fossils they occasionally contain.[1] Unfortunately the results of this long investigation have never been published. It was, however, evident that they were of a nature to confirm the views he had been originally led to form.

Another investigation in which he took an active part was that relating to the evidence bearing on the Antiquity of Man. It will be remembered, that Mr. Prestwich considering that the testimony of the workmen at the Amiens pits required confirmation, returned a second time, in 1859, to the St. Acheul pits, accompanied by several other geologists, and amongst them Mr. Flower, who, with his usual zeal, set to work himself with pick and spade, and remained for hours at the search, until his perseverance was rewarded by disinterring, with his own hands, an undoubted flint implement almost at the very base of the mammaliferous gravel-beds. His last scientific work was a paper on the theoretical questions connected with these discoveries. In this paper he questioned the conclusions of Mr Prestwich and other geologists, that the valley-gravels are of fluviatile origin, and deposited along old lines of drainage, doubting whether they are due to fluviatile action at all, and whether the flint-implement makers were contemporary with the animals with whose remains the flint implements are found. He also suggested modifications in the nomenclature of the Stone periods.

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[1] He also caused a large number of these flint pebbles to be cut and polished, in order to examine the structure of the organisms they contained.—Edit. Geol. Mag.

While thus differing from his friends on theoretical questions, these differences were always put forward and expressed in that spirit of conviction and kindliness which marked the earnest and amiable spirit of the author, and characterized all his works—even the controversial ones,—never tending to sever, but only to draw closer, the bonds of friendship between the disputants. His charming discourse on the "Study of Natural History" shows the character of the man—his disinterested love of nature—his literary taste, and the importance he attached to the study of the Earth, its Fauna and Flora.

Besides his contributions to Natural Science, we must notice those larger and more elaborate works on theological questions, all of which breathe the same spirit of earnestness, love of truth, varied research, and liberal views. It is not the place in these pages to give an account of his theological works, but the titles of them which are annexed will afford some idea of their scope and tendency.

As an Antiquary Mr. Flower was equally zealous and liberal. His collection of Stone Implements, both of the Palæolithic and Neolithic periods, was second, probably, only to that of Mr. Evans.

We wish space would allow us to dwell at greater length on the works of one who, in the midst of the arduous and engrossing profession of the law, found time to cultivate other branches of human knowledge, and ever showed himself possessed of the true and right spirit of a Naturalist and of an earnest inquirer in the cause of truth.

While engaged last winter in exploring the antiquities and works of art in Italy, he was seized at Rome with the symptoms of a fatal illness, and returned only in time to end his days in April last at his own residence near Croydon, at the age of 65, deeply lamented by the men of science who had the privilege to share his friendship.

The following is a list of his works:—

On the Pleasure and Advantages to be derived from the Study of Natural History. A Lecture. 1857.

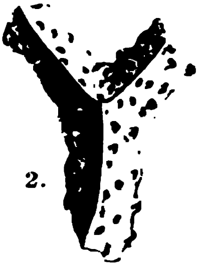
On a Flint Implement recently discovered at the base of some beds of drift gravel and brick-earth at St. Acheul. Quart. Journ. Geol. Soc. 1860.

On some Flint Implements lately found in the valley of the Little Ouse river. *Ibid.* 1867.
On some recent discoveries of Flint Implements of the drift in Norfolk and Suffolk, with observations on the theories accounting for their distribution. Quart. Journ. Geol. Soc. 1869.
Notice of a Kjökken-Mödding in the Isle of Herm. Journ. Anthrop. Soc.
On the relative ages of the Stone Implement Periods in England. Journ. Anthrop. Inst. 1872.
Surrey Etymologies. Journ. Surrey Archæol. Soc. 1865.
Notices of the family of Cobham of Sterborough Castle, Lingfield. Surrey Archæol. Soc.
A Letter to the Lord High Chancellor with reference to the investment of the Cash balances belonging to Suitors in the Court of Chancery, and the mode in which Government Securities are purchased and sold on the suitor's account. Pamphlet. 1859.
Adam's Disobedience and its Results in relation to Mankind as shown in Scripture. 1861. 2nd edition, enlarged. 1871.
On Original Righteousness.
The Apostolic Pandects. 1863.
An inquiry respecting the origin of the Parable of the rich man and Lazarus. 1864.
Forensic Imputations. 1867.

J. P.

MISCELLANEOUS.

Bone Cave in Kirkcudbrightshire.—It has long been familiar to geologists that the western and southern coast-line of Scotland is pierced with caves of different levels, indicating former successive lines along which the sea-waves worked. Unfortunately, owing to the want of limestone or very calcareous rocks, these caves, as a rule, present none of that stalagmite deposit which has elsewhere served so abundantly to cover over and preserve the remains of the ancient denizens of our country, with traces of the presence of man himself. The caves usually open directly upon the coast, with free exposure to the air, so that their floors show nothing but damp boulders and pools of water from the drip of the roof. Recently, however, a remarkable exception to these ordinary conditions has been observed on the wild cliff-line to the south-west of the bay of Kirkcudbright. The Silurian greywacke is there traversed with strings and veins of calcite along lines of joint and fracture, and at one point where an old sea cave occurs, the walls and floor at the cave mouth, and for a few yards inwards, have a coating of solid calcareous matter. Beneath this coating in the substance of the breccia which extends across the cave mouth, as well as throughout the cave earth behind the breccia, a great quantity of bones, with traces of human occupation, have been found. A systematic investigation of the cave, commenced last autumn, is being carried on under the direction of Mr. A. J. Corrie and Mr. W. Bruce-Clarke—the discoverers of the osseous layer. At the present time the following among other remains have been noted:—Bones of ox, red-deer, goat, horse, pig, pine-marten, rabbit, watervole, and other small rodents, together with numerous remains of birds and a few frog and fish bones. Intermingled with these occur fragments of bronze, bone needles, and other bone implements, to the number of more than twenty; one piece of worked stone (a fragment of greywacke) has been found, but as yet not a single chip of flint. A full account of the cave will be published as soon as the investigations are completed.



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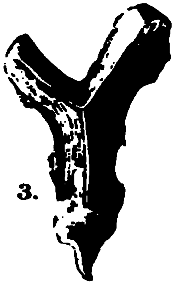

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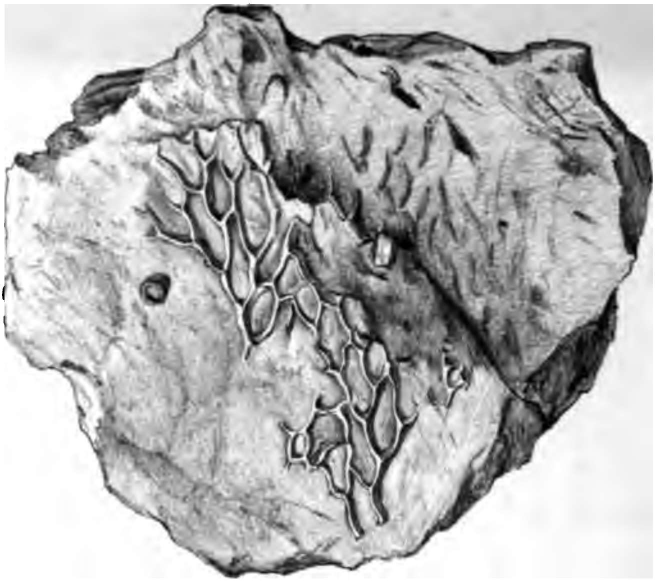

[illegible] Mintern Bros imp.

Carinella cellulifera, R. Etheridge, Jr.
Carboniferous beds, Carluke

THE
GEOLOGICAL MAGAZINE.

No. CXII.—OCTOBER, 1873.

ORIGINAL ARTICLES.

I.—DESCRIPTION OF *CARINELLA*, A NEW GENUS OF CARBONIFEROUS POLYZOA.

BY R. ETHERIDGE, JUN., F.G.S.

(PLATE XV.)

AMONGST a small collection of fossils lately forwarded to the writer for identification, by Dr. Rankin, of Carluke, from the Carboniferous beds of that neighbourhood, are some remains of Polyzoa, peculiar from the combination of characters presented by them, such as have hitherto been considered characteristic of separate genera. In *Fenestella*, Miller, as restricted by King,[1] each interstice or stem of the frond is provided on one side only with two or more rows of cell-apertures, separated by a median keel. In *Polypora*,[2] McCoy, on the contrary, the interstices or dissepiments are not carinated, and the former are always provided with numerous rows of cell-apertures, generally arranged more or less in quincunx, the dissepiments as in *Fenestella*, being non-celluliferous. In the specimens under consideration a combination of some of the above characters takes place, forming a connecting link between the two genera *Fenestella* and *Polypora*. An examination of the accompanying drawings will at once show that the fossils there represented cannot be referred to either of the above, but they certainly appear to be the type of a new genus, which it is proposed to call *Carinella*. Only one species is at present known, which might with advantage be termed *C. cellulifera*.

Carinella cellulifera, gen. et sp. nov.—Polyzoarium composed of angular irregularly disposed anastomosing branches, strongly carinated on both the obverse and reverse faces, but celluliferous only on the former, apparently arising from a common root. No regular distinction into interstices and dissepiments, but the branches bifurcate and re-unite to form hexagonal, pentagonal, and polygonal interspaces or fenestrules, often of most irregular form. On each side the keel on the celluliferous or obverse face are three, sometimes four alternating rows of cell-apertures. The prominent keel follows each bifurcation of the angular ramifications, which are all celluliferous, no separation into interstices and dissepiments being apparent. The cell-apertures have prominent margins. The reverse is longitudinally striate, and the keel does not appear to be quite as strong as on the obverse face.

Carinella agrees with *Polypora* in constantly having more than two rows of cell-apertures on the celluliferous face, but it differs in possessing a median keel. It agrees with *Fenestella* in the possession of the latter, but differs from both it and *Polypora* in the total absence of non-celluliferous dissepiments or cross-bars, and in having the reverse keeled in a similar manner to the obverse or celluliferous face.

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[1] Permian Fossils, p. 35.

[2] Synopsis, Carb. Foss., Ireland, p. 206.

Localities.—Braidwood, Carluke: in the *Fenestella* bed of the 1st Calmy Limestone (Lower Limestone Group). Gair Quarry, near Carluke; in shale over the Gair Limestone (Upper Limestone Group). It has also been obtained from other localities in Lanarkshire by the collectors of the Geological Survey. These will be given in the forthcoming Explanation to Sheet 23, Scotland.

EXPLANATION OF PLATE XV.

FIG. 1. *Carinella cellulifera*, twice the natural size.
„ 2. Celluliferous face of the same, six times the natural size.
„ 3. Reverse of the same, showing keel and striæ, six times the natural size.

For these very excellent drawings I am indebted to my friend, Mr. H. Skae.

II.—ON ANALYSIS OF WHITE CHALK FROM THE COUNTY OF TYRONE, WITH NOTE ON THE OCCURRENCE OF ZINC THEREIN, AND IN THE OVERLYING BASALT.[1]

By EDWARD T. HARDMAN, F.R.G.S.I.; of the Geological Survey of Ireland; Associate of the Royal College of Science, Dublin.

I WAS led to make this analysis with the view of determining if possible whether the extreme hardness of the Irish Chalk were due to either a chemical, a mechanical, or a calorific alteration, from the influence of the overlying basalt. If it were owing to chemical change, we should expect to find a large per-centage of silicates and a diminution in the amount of lime: if to the influence of heat, carbonic acid would be driven off, silica would be in excess, and the presence of the insoluble bases, such as the peroxide of iron, oxide of manganese, and alumina, would become more apparent; while if a mechanical cause or pressure were the reason, no change would take place in the relative amount of the constituents. I believe the result seems to show that the induration of the Chalk must be set down chiefly to the last agency,—if to anything apart from the original formation of the rock,—and that the power of alteration exerted over it by the heat of the molten basalt has been small indeed. At the same time a certain addition has been made to it by means of water holding chemical bodies in solution.

The following is the result of the analysis. The specimens used were obtained from an old quarry in the townland of Legmurn, about a mile and a half north-east of Stewartstown. The Chalk is so indurated as to be in reality a hard splintery limestone.

$CaCO_3$	97·320	ZnO	traces.	Very perceptible even in small quantities of the Chalk.
$MgCO_3$	0·890			
SiO_2	0·537	BaO	a trace.	
Al_2O_3	0·273	SrO	a trace.	
Fe_2O_3	0·095	K_2O	Amount not estimated.	
FeO	a trace.	Na_2O		

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[1] Read before the Royal Geological Society of Ireland, June 11, 1873.

By the kind permission of Prof. Galloway the quantitative analysis was made in the laboratory of the Royal College of Science, Dublin.

As the potash and soda were very small in quantity, it was not worth while to estimate them, and the residue insoluble in hydrochloric acid, amounting to but 1·565 grains in 297·5 of the limestone, was considered to be silica, being too small to analyze.

There is nothing remarkable about the other constituents, except the presence of zinc, which I believe it is unusual to find disseminated in an invisible form over a large extent of rock, even in trifling local amount. At any rate I have never seen it given in such analyses as I have met with, of limestone or other rock,—although its ores are known to be often associated with the former; but for the most part as subsequent deposits in cavities of erosion.

I happened to discover its presence in the Chalk accidentally, while examining it in the wet way for titanic acid, which I imagined might be expected to result from the decomposition of titano-ferrite in the overlying basalt. The titanic acid did not reveal itself, but a strong indication of zinc appeared. I then determined to test it in the dry way, and on fusing some of the powdered chalk with carbonate of soda on charcoal, I was able actually to reduce a small portion of the metal so as to obtain a few spangles of it. These, when subjected to the proper tests, gave the usual re-actions with the blow-pipe which characterize zinc compounds. I repeated this experiment several times with different specimens of the Chalk, and was able to satisfy myself fully of the presence of the metal in it.

As from some of these trials zinc appeared to be in such quantities that it might be estimated, 297·5 grains of the powdered chalk were taken, dissolved in hydrochloric acid, treated with sulphuretted hydrogen, in the expectation that some of the metals precipitable by it were present; silica, iron, and alumina were removed, and it was finally examined for zinc. This was unmistakably proved to be present, but unfortunately in too small a quantity to weigh. In fact it appears to be unequally disseminated throughout the rock, for while in some very small portions submitted to qualitative analysis it was extremely perceptible, yet in the large quantity above named it seemed disproportionately small.

It thus became a question whether the metal occurred merely locally, or was widely scattered over a large area of the Chalk. I therefore examined a specimen of hard white chalk from Slieve Gallion Carn, in the Co. Derry, some eight miles, as the crow flies, north-west of Legmurn. It occurs there as an outlier on the New Red Sandstone, and underlies the basalt. The specimens obtained here lay but two feet below the basalt, but could not be distinguished in appearance from the others, which were taken at some distance from the edge of the dolerite. It contained a few slightly reddened flints however. The examination was only made for zinc, and was done as before, by fusing a portion with carbonate of soda before the blow-pipe.[1] As was expected, the metal was here also reduced, and was perfectly visible, apparently in the same quantity as in the first specimen. Its presence was then confirmed by other tests.

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[1] Fletcher's hot-blast gas blow-pipe was used, and by its means a comparatively large quantity of the powdered chalk and of the basalt (see *post*) could be treated.

Although this of course affords no direct evidence as to the existence of the metal throughout the chalk here, it is curious that it should be detected in samples procured at such a distance from each other if it were not so.

The idea then arose that it might have been carried down from the basalt in aqueous solution. Accordingly a piece of the basalt which crops out about 100 yards north-east of the Chalk Quarry in [illegible] was procured,[1] and I examined in the same way as the Chalk had been. In this also zinc was discovered, and in very appreciable amount; so much so, that I doubt not had I had time to make a quantitative determination, I should have been able to estimate it.

There can be little doubt, therefore, the zinc that occurs in the Chalk, probably as carbonate, which would be indistinguishable on inspection, has been carried down from the basalt in aqueous solution. In what form it exists there however must be uncertain.

It is true that in most mineralogical works there is no direct mention of the occurrence of zinc compounds in igneous or volcanic rocks,[2] but it seems to be implied in one or two instances; and it certainly appears to be quite possible that many of them would be formed both in the wet and in the igneous way, in such rocks. At first sight it might be surprising that such a volatile metal as zinc would withstand the great heat of molten rock and remain undissipated; yet several zinc minerals have been artificially formed in furnaces, and under other applications of heat. Franklinite, a variety of magnetite containing zinc and manganese, found workable in the metamorphic Silurian limestone of New Jersey, has been imitated by Delesse, by the action of sesquichloride of iron and chloride of zinc on lime, under the influence of heat.[3] Zincite or red oxide of zinc has been obtained in the iron furnaces of Silesia and New Jersey, and in zinc furnaces at Siegen.[4] Blende has resulted artificially from subjecting heated oxide or silicate of zinc to the vapour of sulphur, and is found in the furnaces at the Freiberg smelting works.[5] "It occurs in both crystalline and sedimentary rocks."[6]

Thus it would seem to be very possible for some zinc compounds to have had a contemporaneous origin with the basalt. On the other hand, the zinc may have been introduced at a later period by the agency of water, in the same way that carbonates of lime, magnesia, and iron, have been, and notably the zeolites, which are so abundant in that rock. This is perhaps the most likely to happen; but in either way, most of the zinc minerals might have been brought in. There is nothing therefore remarkable in the fact of the metal being detected; and it might be met with oftener were it looked for during the analysis of rocks, just as other metals known to exist in certain rocks seldom appear in their published analysis.

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[1] The spot from which the basalt was obtained is about 300 yards from the Chalk Quarry.

[2] Mr. Thomas Davies, F.G.S., of the Department of Mineralogy in the British Museum, informs me that Professor Scacchi, of Naples, states that Blende (Zn S) occurs occasionally—in association with galena—in the volcanic breccias of Monte Somma.—EDIT. GEOL. MAG.

[3] Dana's System of Mineralogy (1868), p. 153.

[4] *Ibid.* p. 135.

[5] *Ibid.* p. 50. (Here, too, the removal of the obnoxious zinc from the lead is a most difficult problem. See Percy's Metallurgy of Lead, p. 325.)

[6] *Ibid.* p. 49.

[It can only be a matter of surmise as yet with regard to the form in which the zinc exists in the basalt. A possibility might be suggested, however, that some of the magnetite which is found as an accessory mineral in that of Antrim[1] may be of the variety Franklinite. Some of the spinels also, to which this is allied,[2] and which themselves number a zinc compound, have been found in vesicular cavities of the volcanic rocks of Monte Somma;[3] and at least one instance is given of the discovery of *metallic* zinc in basalt. It is said, by G. Ulrich, to have been found by a quarryman in a geode in basalt, near Melbourne, Victoria, associated with Smithsonite and cobalt bloom; the specimen weighed 4½ ounces. Dana, however, considers the account to be somewhat doubtful.[4]][5]

With this exception, the analysis shows little that could be ascribed to chemical alteration, nor has there been any loss of carbonic acid, so that the original heat of the superincumbent basalt, which has been so often relied on as the means of hardening the chalk, and reddening the flints, must be quite out of the question. Perhaps a great deal too much power has been ascribed to this agent; as may be conceded when we recollect the unaltered condition of the intervening leaf-beds and lignite, which do not appear to have been affected by it, although naturally very susceptible of its influence.[6]

But when it is remembered that in the Hebrides the basalt reaches a thickness of between 3000 and 4000 feet,[7] and that the Irish basalt, although now but from 500 to 1200 feet thick, may have had similar proportions, there is no difficulty in referring the consolidation of the Irish chalk to pressure alone; for, taking the original thickness of the basalt at only 3000 feet, the pressure on each square yard of underlying chalk would be about 2000 tons.[1]

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[1] Prof. Hull "On the Structure of Trap Rocks," GEOL. MAG., April, 1873.

[2] Manual of Geology (Jukes and Geikie), p. 63 (Article by W. K. Sullivan, Ph.D.).

[3] Cotta, Rocks Classified and Described, p. 61.

[4] System of Mineralogy (1868), p. 17.

[5] The above bracketed portion was added after the paper had been read, as the possibility of zinc occurring in the igneous rocks was disputed at the time. The method of analysis was also said to be unreliable; but it is a far more certain test for small quantities, than the wet process. By it a metal was obtained. This was white and brittle; it dissolved readily in dilute hydrochloric acid; and the solution of the metal heated on charcoal with nitrate of cobalt gave a very distinct bright green incrustation. There is but one metal that exhibits all the above characteristics, and that is zinc.

Voltzite ($Zn\,S + ZnO$) occurs at Rosieres, near Pont Gibaud, Puy de Dome (Dana's Mineralogy, p. 50). No mention is made of the rock in which it is found; but in Scrope's "Volcanoes of Central France," both in the maps and in the letterpress (pp. 56, 57), the rocks of that neighbourhood are shown to be granite and recent basalt; no other than igneous rock is laid down on the maps, nearer than about 18,000 metres. (Edition 1858.)

[6] Bischof mentions that small pieces of clay-slate caught up in lava flows were afterwards found to be quite unaltered.

[7] Manual of Geology (Jukes and Geikie), p. 69.

The analysis, which is extremely similar to one by Mr. Wonfor, of the Chalk of Cushendall, Co. Antrim,[2] shows that it is a limestone of very great purity, the per-centage of siliceous matter being so small as to be quite insignificant. It should therefore be of the highest value in many chemical manufactures, especially that of bleaching powder. But it is remarkable that although in the North of Ireland an immense quantity of this material is used up, it is not made there, but is mostly imported from Glasgow and Lancashire. So far as I know, there is not a single Chloride of Lime Works in Ulster.[3]

III.—A BRIEF MEMOIR OF THE GEOLOGY OF DORSET.

By J. C. MANSEL-PLEYDELL, F.G.S.

Part II.

(*Continued from page* 413.)

AS the sands and clays of the Hastings series lie conformably on the Purbeck Beds, it is probable that the same area which formed the embouchure of the Purbeck river performed still the same office during the Hastings Sand age; but the entirely different character of the deposit shows at least that the soil of the country drained by the latter was different from that which supplied the former; and it is evident also that, in the district under consideration, the motion of the water of the Hastings river was much more rapid, from the abundance of sand, coarse quartz, and gravel with pebbles.

This lower member of the Wealden consists of sand, sandstone, calcareous grit, and shale. At Swanage and Worbarrow the calcareous grit alternates with red and green sandy clay; it contains bones of the Iguanodon and portions of silicified coniferous trees, the stone into which they are converted being dark-brown in colour, and receiving a fine polish. It does not effervesce with acid. The Hastings Beds form the north side of Swanage and Worbarrow Valley, and pass through Godlingston, Corfe, Church Knoll, Steeple, and Tyneham; a small patch appears at Mewps Bay, Lulworth, and Man of War Cove. Their junction with the Purbeck Beds is favourably exposed at Worbarrow. In the little cove between the Tout and Gad Cliff, about fifty feet of clay alternates with beds of contorted limestone; at Swanage it is invisible, being masked by a fault. The only other appearance of this bed occurs between Chaldon and Holworth, flanked by the Greensand on the south, and the Ridgeway fault on its northern side. It is evident from our review of the Wealden and Upper Oolite Beds, as represented in this neighbourhood, that they are quite unconformable to the Cretaceous system, which not only overlaps them gradually, but covers them occasionally. At Osmington Mills, within less than a square mile, the Upper Greensand is in contact successively with the Hastings Sands, the Purbeck Beds, and the Kimmeridge Clay. Here the alternation of fine clays and sands peculiar to the Swanage Beds with the coarse drift of Worbarrow plainly reveals the swelling and subsiding of the ancient river which covered them eastward. From the presence of iron the Rev. O. Fisher considers the deposit to have been furnished from the New Red Sandstones of Devonshire.

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[1] The Chalk of Tyrone is in fact curiously shattered and split up into small irregular parallelopipeds, which appears to be due to more than ordinary jointing. The great pressure may have had something to do with it.

[2] Journ. Royal Dub. Soc., July, 1860.

[3] A quantity of the Antrim Chalk is, however, exported to England for manufacture there.

Of the gigantic reptiles of the Wealden age the Dorsetshire beds produce two, *Iguanodon Mantelli* and *Megalosaurus Bucklandi*. Mr. S. H. Beckles, F.R.S., describes in the Geological Journal, vol. xviii. p. 446, casts of footprints in Swanage Bay occurring in two bands of sand-rock of the usual tripodal shape, about fifteen inches long, which may be the footprints of a Wealden Dinosaur, or perhaps of a Batrachian.

The Flora of the Wealden contains *Coniferæ*, *Cycadeæ*, and Ferns. In 1855 the *Gyrogonites* (so named by Parkinson in 1822), spore-vessels of the *Chara*, were found in the Hastings Beds of the Isle of Wight, a genus common in the Tertiary strata, but not found before this in the Secondary rocks.

The variegated Wealden Clays and Sands are about 1800 feet thick at Swanage, 725 at Worbarrow Bay, 660 at Mewps Bay, 462 on the east side of Lulworth Cove, and 172 at Man of War Cove, showing in a very remarkable manner the attenuation of the beds which takes place westward; this peculiarity is not restricted to the Wealden, but extends to the Lower Chalk as well.

The Purbeck Beds have been examined and mapped in great detail by Mr. Bristow, and published in the works of the Geological Survey of Great Britain. In Sheet 22 of the Vertical Sections every bed is shown on a scale of 10 feet to one inch, with full lithological and palæontological descriptions.

Lower Cretaceous or Neocomian.—Punfield beds.—A remarkable bed, partly marine and partly of estuarine origin, lies at the top of the Wealden Beds at Punfield, Worbarrow, and Mewps Bay. It has long been known to geologists as differing from the freshwater Wealden in mineral character, and in its animal remains, clearly indicating the gradual return of marine conditions which continued throughout the Cretaceous period.

A marine band, 21 inches thick, rests on the variegated beds of the Wealden, dipping due north at an angle of 65°; Mr. Judd, who has recently separated these beds from the Wealden Series, to which they were before attributed, divides this marine bed into three parts, the lower being a shelly Limestone, containing concretions of argillaceous Limestone, yielding Ammonites, *Vicarya*, and other marine shells; the middle portion is almost entirely made up of Oyster-shells with a few dwarfed specimens of *Corbula* and *Cardium;* the upper portion contains but few shells, and, like the middle, is mixed with much carbonaceous matter. The narrow band is succeeded (upwards) by a series of ferruginous sands, about 153 feet thick; its middle portion is composed of ferrugineo-calcareous rock, with Oysters and other marine shells. The uppermost band, which is a dark-blue finely-laminated shale, in part Cypridiferous, with thin bands of Limestone, made up of *Cyrena*, *Ostræa*, etc., is at present covered over by the *débris* from the beds above.

At Worbarrow the formation is about 68 feet thick, comprising a thin well-marked band of ironstone containing vegetable markings and casts of marine shells, with beds of grey and whitish laminated clay and bands of nodular ironstone. These ironstones contain casts of marine shells; also beds of light-coloured, sometimes pinkish, sand, with much carbonaceous matter.

The Punfield formation is exhibited at Brixton Bay, a little to the west of Atherfield Point, at Compton Bay, and Sandown Bay in the Isle of Wight.

GAULT, CHALK MARL, AND LOWER CHALK.—It is difficult distinctly to recognize the sub-division of the lowest beds of this series; only on the eastern side of the county is it of any importance; it accompanies the Chalk in its varied sinuations from Abbotsbury to Corscombe, and occupies the summits of the insulated hills above Lyme Regis, Lewesdon, and Pillesdon; it reposes successively on the Lias at Lyme, on the Inferior Oolite at Golden Cap and Shipton Gorge, on the Forest Marble at the Knoll of Puncknoll, on the Oxford Clay south of Abbotsbury, on the Kimmeridge Clay west of Osmington, and on the Purbeck Beds east of Abbotsbury. Its valleys of denudation are seen at Askerswell, Compton Valence, and Winterborne Steepleton. The Gault and Chloritic series has its greatest superficial development in the vicinity of Shaftesbury, and produces strata of chert, beneath which lies a band of sandstone, of great economic value, on account of its power to resist the decomposing action of the atmosphere; it is extensively used for building, the angles of the worked blocks retaining their original sharpness for centuries,—the marks of the chisel are as fresh now as when first cut. A narrow zone flanks the base of the Chalk range from Ballard Down to Worbarrow, a fault brings it to the surface at Mewps Bay, it forms the base of the eastern side of Lulworth Cove, and dips beneath the sea at Durdle Door. At Batts Corner it re-appears and forms the coast-line to Ringstead Bay, where a fault throws it northward above Holworth, and it follows the Kimmeridge Clay to Osmington, whence it turns eastward to Chaldon, skirting the north side of the Ridgeway fault from Poxwell to Bincombe. It occupies the heights above the village of Abbotsbury, and, after passing Gorwell and Little Bredy, it forms the base of the escarpment of the eastern side of the vale of Bredy.

It is not difficult to conjecture that these Lower Cretaceous Beds were continuous and extended over a large area westward, previous to the denudation which has so seriously affected this district. In the neighbourhood of Longbredy they are much disturbed: after encountering several lateral and vertical faults, it forms the base of Eggardon Hill; from Chilcombe it continues in a southerly direction through West Compton and Wynford Eagle. It fringes the base of two Chalk outliers, the major axis of the larger one taking a north-esterly direction from Frome Vauchurch through Toller to Chedingtn, that of the lesser from Wraxall to Melbury. The outliers Pillesdon, Lambert Castle, Stonebarrow Hill, Golden Cap, and ype Down, form the most western representatives of the series: flanks the great Oolitic vale of Blackmore from Melbury to haftesbury with only one interruption at Buckland Newton. At yon's Gate a spur of the series takes a southerly direction, and ccupies a narrow valley to Cerne Abbas; small outliers occur at ydling, Holcombe, and Hilton.

The Chloritic Marls at the base of the Chalk-range which bounds e southern and eastern sides of the Vale of Blackmore and the nstey valley are very fossiliferous; the uppermost bed, consisting an argillaceous limestone, is characterized by the Cephalopod *caphites æqualis;* its principal development is at Chard, Monckton, ranborne, and Chaldon, where it does not exceed eighteen inches thickness.

In the palæontological collection of the British Museum is the em of a tree-fern, *Caulopteris punctatus,* from the neighbourhood Shaftesbury; it is a cast in sandstone, and exhibits indications of ternation of climate, or seasonal interruptions to its growth.[1]

UPPER WHITE CHALK WITH FLINTS.—A marine formation of great ickness, consisting of nearly pure carbonate of lime precipitated d deposited at the bottom of the sea, and in some cases consisting from ninety to ninety-five per cent. of Foraminifera. The differce between the Upper and Lower Chalk is the absence of flints in e latter; there are fossils special to each division, most of which idence deep-sea conditions.

Denudation has been actively carried on wherever the Chalk rmation exists in Dorsetshire, but owing to the absence of definite arks indicating any particular horizon, it is difficult to determine s relative position. The beds of flints which cover extensive tracts Chalk containing undisturbed layers of flint, afford evidence not ly of the immense thickness of the original mass, but also of the ormous amount of material which has been removed. The whole roup may be viewed as one continuous series, with a Fauna which ries no more than might be expected from the varied circumstances its deposition through a lapse of ages. The beds rise at Chilmbe with a bold escarpment characteristic of the formation; from hilcombe Hill east of Bridport to Lulworth, whence it is contracted to a narrow elevated isthmus, to Ballard Down, which divides wanage and Studland Bays. The most southern extension is on e west side of the county south of the village of Abbotsbury, its rthern boundary flanks the vale of Melbury, and with various dulations towers over the Vale of Blackmore from Minterne to aftesbury, and continues conterminous with Wiltshire, from thence Boveridge, where it takes a southerly direction to Wimborne, and esterly to Bere Regis, the Woolwich and Reading Beds reposing it. From Corscombe to Shaftesbury it rests exclusively on the

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[1] See paper by Mr. W. Carruthers in GEOL. MAG., 1865, Vol. II. p. 484, Pl. XIII. g. A.

Upper Greensand, but here and there it is concealed by newer deposits; it has a dip varying from 10° to 90°. At Ballard Down the Chalk is vertical, the horizontal strata being suddenly turned upwards into a curve, which is easily traced by the layers of flints with which it is interspersed; this arises from a fault the evidence of which is seen in its greatest intensity and force at Cocknowle and again east of Corfe Castle. The Upper Chalk (whose characteristic fossils are *Rhynchonella octoplicata*, Sow., *Lima spinosa*, Sow., and *Marsupites Milleri*, Mant.) prevails on the northern side of the range meeting the Tertiaries at a very low angle, dipping gently to the north-east beneath overlying sands and clays. The Lower Chalk is well exposed at Houghton and Hilton, where the beds are much disturbed; they contain several species of *Inoceramus* and the Brachiopod *Rhynchonella Cuvieri*.

TERTIARY SERIES.—Lower Eocene.—The lowest of this series, the Thanet Sands, are absent in Dorsetshire, and they do not appear far to the west of London. The Woolwich and Reading Beds, the next in succession (with the exception of two isolated spots in the neighbourhood of Blackdown and Bincombe), do not appear west of Knighton. They are composed of sands, pebble-beds, and clays, accompanied in some places at the base with green-coated flints, which may be favourably seen at Studland Bay and in a pit near Pamphill, Wimborne; a small section of light-red mottled clays and pebble-beds over the Chalk occurs at Lulworth Park. At Crendle Common near Cranborne is a red-mottled plastic clay, extensively used for pottery of a coarse character. At Chalbury Hill near Horton are pale-grey mottled clays, with an overlying bed of flint pebbles; at East Bloxworth this series is represented by a pale-grey sandy pipe-clay, containing leaves of plants. From the neighbourhood of Cranborne to Wimborne and Bere Regis it overlies the Chalk with a discontinuous broken margin; at Tincleton a narrow isthmus of Chalk intervenes, and the Poole Tertiary basin is its utmost western boundary at Yellowham. The alluvial valley of the Frome divides it at Lewell, and, after making a curve through West Knighton, where the mottled clays almost disappear and are replaced by coarse sands, irregular pebble-beds, and whitish clays, it reaches the southern margin of the Poole basin near Broadmayne, and at Littlemayne the Chalk is overlaid by sands which in one place are concreted into large blocks of sandstone, the ordinary Druid Stone; it flanks the south side of the Poole basin from Warmwell, Winfrith, and Wool, where it takes a southerly direction to Lulworth, and joins the Purbeck range at Whiteway, which commences about a mile north of Durdle Door, extending to Studland; it follows without interruption the northern base of the Chalk range at West Lulworth; there are small outliers also at Milborne St. Andrew, Came, Bincombe, Bradford Peverell, and the lofty Blackdown. The Woolwich and Reading Beds form a salient feature in the landscape, owing to the prevalence of oak, which grows freer and better upon them than on the strata above or below; their line of demarcation may be at once recognized by this peculiarity.

The blocks of Grey Wethers, Sarsen Stones, or Druid Stones, which are scattered over the surface of the Chalk and older formations, such as the saccharoid sandstone of Portisham and Bridehead valleys, or the red sandstones at Winterborne Whitchurch, Milborne St. Andrew, etc., are thought by Mr. Prestwich to belong to the Woolwich and Reading Beds. Near the village of Broadmayne on the Wareham road are several blocks of indurated masses of sandstone (Druid Stones) *in situ*, left denuded by the force which scooped out the valley. The Portisham and Bredy breccias differ, inasmuch as they are conglomerates of flint, and transported from their original position by torrential action into these deep valleys.

London Clay.—Immediately resting on the Woolwich and Reading Beds is the basement-bed, as termed by Mr. Prestwich; it is usually composed of ferruginous brown clayey sands. At East Bloxworth it contains nodular concretions of clay-ironstone, peroxide of iron, and rounded flint-pebbles: it is a constant attendant of the Woolwich Series in the county from Chalbury to Knighton, but is absent on Piddletown Heath and the outliers westward to Blackdown.

Middle Eocene.—Lower Bagshot.—These beds consist of a thick deposit of sand and clays; they are extensively developed on the eastern side of the county, forming the main portion of the clay and heath district included within the Poole basin. They are remarkable in Dorsetshire for their important strata of pipe-clay, which is worked at Creech Grange, Nordon, and Rempstone. The export of this clay in 1870 from Poole was 60,210 tons. Mr. Prestwich considers the Lower Bagshot series, both in Hampshire and Dorsetshire, to be derived from the wear and denudation of land consisting of the older and crystalline rocks; the condition of the material being similar to rocks such as now form the strata of Cornwall and Brittany. Mr. Maw, however, thinks that these beds have been derived from the denudation of a Chalk-tract. The grains are larger and coarser at Poole and Studland than in the Isle of Wight, where they pass into grits. An old land seems to have existed, of which Cornwall and Brittany remain, the intermediate portion having been submerged and destroyed; the fossil remains point to the same conclusion, for the plants they contain are more numerous and better preserved as we proceed from east to west, and become more plentiful at Bournemouth, Studland, and Poole than at Alum Bay. In the compact clays of these localities there are not only Dicotyledonous leaves but numerous fronds of ferns allied to *Gleichenia*, which are well preserved, with their fruit, a genus which existed in the Cretaceous and Oolitic periods and now inhabits the Cape of Good Hope and New Holland. In the midst of these leaf-beds, in Studland Bay, freshwater shells of the genus *Unio* attest the freshwater origin of the white clay.[1] The fruit of a member of the *Arelia* family, now confined to North America, New Zealand, Japan, and the East, has been found at Bournemouth by Mr. Mitchell. Fine specimens of the leaves of a Palm (of the genus *Sabal*) have been found at Studland and Corfe. The river of that period may have passed through a district of granitic and syenitic rocks which brought down these pure kaolin clays. The coarser materials and quartzose grits were probably drifted from their original position either by periodical or intermittent floods.

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[1] Lyell, Student's Elements of Geology, 1871, p. 238.

The occurrence of isolated Tertiary patches resting here and there on the Chalk, of which the one at Tollard Royal is furthest from the central mass, leads to the supposition that denudation has removed the large masses which intervened, and, as has been already hinted, probably extended far over the Chalk below.

The heaths of Bere Regis, Affpuddle, and Piddletown, are here and there pitted with circular conical hollows, resembling the upper portion of an hour-glass; they vary from 60 to 80 yards in circumference; the largest is 280 yards round. They are supposed to be swallow-holes, the result of the dissolution of Chalk by means of the carbonic acid contained in the rain-water, and the subsidence of the superjacent sands into the resulting hollow causing a depression of the surface like that which takes place in the sands of an hourglass soon after it has begun to run. The Rev. O. Fisher considers that the formation of these pits was subsequent to the outspread of the superficial gravel.

SUPERFICIAL GRAVELS, etc.—Gravels and Brick-earths cover the surface of the heath-lands, as well as large portions of the Chalk and the Oolites, on the border-lines of the Vale of Blackmore.

The High-level Gravels are all rounded by water-action, and originate from beds of which we have fragmentary traces in several parts of the county, but which do not now exist nearer than Cornwall, porphyry, granite, and quartz being their constituent parts; they cover the table-land between Bournemouth and Poole, which forms the eastern extremity of the extensive tract of land of which Picket Plain and Ochnell form the northern boundary, and were probably spread out previous to the wearing away of the surface of the present existing valleys. The lower gravel-beds are represented largely throughout the county, not only covering the deep combes which intersect the coast-line, but lie at the base and sides of many of the inland valleys. Those of the Stour and Piddle have yielded remains of *Elephas primigenius* and *Rhinoceros tichorhinus*; at Gains Cross near Durweston tusks of the former and teeth of the latter were met with in the railway-cutting in a bed of flint-gravel 60 feet above the river. Mr. Shipp (of Blandford) has a good collection of the remains of these pachyderms, from a pit in the nursery-gardens between the town of Blandford and the turnpike-gate on the Dorchester road; molar teeth of *Elephas primigenius* were found some years ago at Dewlish, in a tributary of the river Piddle. The Avon too has yielded elephants' teeth in gravels 40 feet above the river. Elephant, Bison, and Deer remains were exhumed from a bed of gravel at a combe at Encombe, the seat of the Earl of Eldon.

There are evidences of man's occupation in the cliffs near Bournemouth in the occurrence of flint implements among the gravels 120 feet above the sea-level. Owing to the absence of organic remains, it is impossible to decide as to the origin of these gravels, whether

ey result from fluviatile or marine agency. Mr. Codrington con-
ders the gravels covering the table-lands at the highest levels are
far greater antiquity than the valley-gravels of the rivers, which
ere probably formed previous to the disruption of the Isle of
Vight from the mainland; also that the rivers reaching the sea by
oole Harbour, Christchurch, and Southampton, were affluents to an
stuary opening into the sea in the direction of Spithead.

The last movement appears to have been one of subsidence, and
e occurrence of several submerged forests around our coasts gives
ood reason to lead to this supposition. Those of Bournemouth and
n the north side of Poole Harbour, Sir Charles Lyell makes an
ception to, and attributes their submergence in modern times to
e washing out of the subjacent sandy strata on which they rested,
nd not to a general subsidence or change of level. In several parts
f the county, especially on the chalk-uplands, drift-beds occur of
cal origin varying from flint-rubble and brick-earths to sandy
lays. Sponges, Echinoderms, and Brachiopods (the usual Chalk
ssils) are plentiful in these deposits, which represent the redistri-
ution of the older gravels during the Pleistocene age.

SUB-AERIAL DEPOSITS.—Chesil Bank.[1]—This remarkable beach
ns from Portland to Burton Bradstock, a distance of 18 miles.
lessrs. Bristow and Whitaker consider it to have been an ordinary
each subsequently separated from the mainland by denudation. It
connected with the mainland from Burton to Abbotsbury, where
narrow channel, the Fleet, which extends to Wyke Ferry, separates
. At Abbotsbury its base is about 170 yards in width, and its
rest 22 feet above the level of the sea. At Portland its base is 200
ards wide, and its crest 42 feet in height. The separation of the
nd from the beach is, doubtless, owing to the configuration of
e coast-line, which is without any high land or cliff from Burton
Abbotsbury; and the several streamlets which, through the im-
erviousness of the subsoil, and eastward trend of the coast, are
iverted from their seaward course, succeed each other, and rill after
ll by their united power attain sufficient force to excavate a chan-
el, while the influx and reflux of the tide have contributed towards
e formation of the Fleet, on whose bosom nearly 1000 swans
am,—the unique and enviable possession of the Earl of Ilchester.
he Isle of Portland has acted as a base or breakwater in the
rmation of the Chesil Bank. Between Studland and South Haven
ere is a large accumulation of shingle, derived from the submerged
eds as well as from the re-formation of older gravels.

The raised beach at Portland Bill consists of pebbles cemented
gether with comminuted shells; it is 30 or 40 feet above the sea-
vel, and about three feet thick. A projection southward shows
nother conglomerate with shells, chiefly *Littorina littorea*, *Littorina*
ttoralis, and *Patella vulgata*. This ancient beach terminates after a
ourse of 250 yards. A bed of shingle caps the cliff at the Bill, and

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[1] See a paper "On the Formation of the Chesil Bank," by H. W. Bristow, and
. Whitaker, GEOL. MAG. Vol. VI. p. 433 (1869). Also J. Coode in Proc. Inst.
iv. Eng. vol. xii. p. 520 (1853).

extends some way inland.[1] Traces of an upheaval are absent on the mainland owing to the destructible character of the coast-line. There are some other instances of sub-aërial deposits in the county; the most remarkable of these is at Blashenwell, between Corfe Castle and Kingston, where a tufaceous deposit about 10 feet thick, containing land, fresh-water and marine shells, bones of animals, and wood, is spread over the clays of the Hastings Sands at their junction with the Purbeck Beds; it appears to have been the site of a small lake which became silted up by the deposition of lime held in solution in the water which passed through it. The source which supplied the water of the lake still exists, and flows into the Corfe river by the channel it has cut for itself through the tufa. The presence of marine shells may be accounted for by the agency of man, during the establishment of an ancient settlement on the banks of the lake; this supposition is strengthened by similar evidences in the neighbourhood, two of which are close at hand on the Kimmeridge Cliffs, showing a lengthened occupation by man, and where the remains of sea molluscs, bones of animals, and the accumulated fragments or refuse of human food, are present. It seems scarcely possible that any depression of the Corfe Valley on the north or south of the Chalk-range could have been the means of introducing marine organisms even with the aid of a tidal river.

Until recently the Coal-measures were supposed to offer the only proofs of an ancient Flora, but the presence of plants at every geological period is now incontestably established.[2] The Devonian epoch presents *Coniferæ*, *Sigillariæ*, *Calamites*, and Ferns, as well as fruits, such as *Cardiocarpon* and *Trigonocarpum*, which are also Carboniferous. The earliest known Insects are in the Devonian strata of St. John's, New Brunswick. The Permian Flora have a resemblance to that of the Coal-period; the Trias plants are chiefly analogous to those of the Secondary rocks. During the Oolitic period the abundance of the *Cycadeæ* compared with the diminishing ratio of *Equisetaceæ* and Ferns points to the existence of a clearer atmosphere and lower temperature, although a higher one than that which now prevails in Europe. Among the vegetable remains of the Lias, several species of *Zamia* have been found at Lyme Regis. At the base of the Upper and Lower Lias, respectively, Insect-beds occur; containing, besides Insects, small Fish and Crustacea, marine shells, as well as Ferns, Cycads, and leaves of Monocotyledonous plants, and apparently brackish and fresh-water shells. The Insects include wood-eating and herb-devouring beetles, and some grasshoppers. There are evidences of a terrestrial and marine vegetation from the lowest to the uppermost beds of the Oolites, and, though the sequence of the genera has not as yet been traced through each successive stage, they re-appear between intervals of several ods. The Flora of the Wealden is characterized by a great ndance of *Coniferæ*, *Cycadeæ*, and Ferns, and by the absence of 'es and fruits of Dicotyledonous Angiosperms. *Gyrogonites*, or re-vessels of *Chara*, so plentiful in the Tertiary strata, were nd in 1855 in the Hastings Beds of the Isle of Wight. The ›cene Beds of Europe, which have probably their only English ivalents at Bovey Tracey in Devonshire, present a vegetation 'ering little from that of the present day. The plants of the merged forests of our coasts at Cromer, Torquay, and elsewhere, tain identical species with those now growing in England.

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[1] When visiting the Isle of Portland in August last in company with Mr. Prestwich, that gentleman pointed out to me undoubted proofs of Glacial action which had hitherto escaped notice.—J. C. M.-P.

[2] See paper by H. Woodward on the Carboniferous and other Old Land Surfaces, GEOL. MAG., 1871, Vol. VIII., p. 492.

'rom what has been already brought before our notice it is ır that Araucarias, Pines, Cycads, Zamias, and other exogenous nts now growing, have their generic representatives as early as Secondary epoch. The persistence of a species through more n one geological period can seldom be traced; gaps intervene, l it is only indirectly that the changes which have taken place the earth's surface can be determined, the evidences being too quently rendered obscure by the superincumbent beds, or placed ›gether beyond our reach in the depths of the sea. The fact that Cretaceous beds of Dorsetshire rest unconformably on the beds ow shows that a great interval of time elapsed between the ›osition of the two series, and accounts for the dissimilarity of ir Faunas. There are instances, however, where the chain of is unbroken, and uninterruptedly carried on, although accomied by the continual appearance of new forms.

'ote.—The Geology of the County of Dorset is illustrated by the following works lished by the Geological Survey of England. Maps on a scale of one inch to a ›, Sheets, 15, 16, 17, 18, 21, 22. Horizontal Sections, Sheets 19, 20, 21, 22, 56. Vertical Sections, Sheet 22.

'rratum.—In the first part of this paper, which appeared in our September nber, at p. 409.

Eleven lines from top of page, *for*, "are in the *British* Museum," *read*, "are in the Ely Museum."—Edit. Geol. Mag.

,—The Palæontology of the Post-glacial Drifts of Ireland.

By Alfred Bell.

HAD hoped that ere this some one better acquainted than myself with Irish post-Tertiary Geology would have collected into › memoir the details scattered throughout the various scienc journals, thus enabling English geologists to compare the er deposits of Britain with those of the sister-kingdom. Since one has done so, I venture to put some notes of my own upon the ›ject before the readers of the Geological Magazine, especially in some recent discussions upon the Irish drift, "Palæontological ›cession" has not received the consideration it may fairly claim.

Formations in different localities, producing groups of fossils iich, if not exactly the same, taken species by species are so in ›ir general aspect, may reasonably be considered to be of the same ›, since it is rarely if ever the case that the same biological conions return at different periods. It may also be assumed that ıere formations in two localities contain faunas widely divergent in their relations to each other, then the conditions under which those faunas existed were not alike, although the physical structure may be the same, and the deposits close to, or even dovetailing into one another. Assuming these premises to be correct, it follows that if the fauna of any given locality is well or fairly known, then the place of such deposit in the geologic scale may be found by comparison with other deposits whose place has been definitely fixed.

The coasts of Ireland are more or less mountainous, the interior country or central plain being nearly flat. Carboniferous Limestone forms the floor of this plain, a line drawn from Sligo to Drogheda Bays indicating its northern boundary, and another line from Galway to Drogheda Bay its southern limits. The whole of this plain (as well as the entire mountainous districts) is much glaciated, rock-scoring abounding where the fundamental rock is freshly exposed, and is covered more or less with *débris*, the greater portion being local in its derivation; a detritus produced at a later period than the ridges of true Boulder-clay, which, by their parallel arrangement with the striations in their vicinity, are evidently due to the same cause, *i.e.* Ice. These are more plentiful in the central parts of the island, West Connaught and Mayo, Longford, Cavan, Westmeath, and Dublin, and thence northwards (but much less plentiful) in the direction of Lough Foyle. A second series commences at the extreme west of Co. Clare, passing northwards into Galway by Loughrea, deflecting southwards into Tipperary.

The effects of glaciation are not equally visible over all the mountain heights, some being smooth and rounded at their very tops, while others beyond a certain line bristle with jagged rock-masses and pinnacles, all below being smooth and bare except for transported rocks. In Connaught the glaciation extends to above 2,000 feet, but in the Dublin-Wexford Hills summits of 3,000 feet are rounded in their outlines. With one exception above 2,400 feet the Cork and Kerry mountains are peaked and rugged, covered with the coarsest angular *débris*, the result of atmospheric action; but Mount Mangerton, singular to say, placed in the very midst of the district in question, is completely rounded, its summit being at an elevation of 2,700 feet.

The greater part of the country, with the exceptions presently to be mentioned, is covered, as already stated, with drift, local in its origin, but modified by the intermixture of rocks, never very large in size, derived from the mountain barriers of the plain.

There is no internal evidence as to the exact age of the limestone drift, since organic remains are rarely present in it. The drift is of two kinds, a top gravel of clean sand and rounded pebbles with little clay, reposing upon a stiff clay full of rounded or angular masses—the "manure gravel" in part of some authors. The top gravel is often piled up into eskers many miles in length.

Perched upon the top of the eskers, scattered over the low grounds or placed high up the mountain-sides, are many large "blocs-perches," some weighing above 100 tons. In the central districts they have floated from the Galway mountains southward over the ieve Bloom range, into King's and Queen's Counties. But west of e Ox and Curlew mountains in Sligo, the shores and low grounds e covered with sandstones and granites transported in the opposite rection.

The largest erratic in Ireland lies in the valley of the river Tay, ar Kilmacthomas, Co. Waterford, measuring 50 × 35 × 18 feet, rried 2½ miles away from the parent rock.

It is singular that no fossils have been noticed in the gravels of so eat a part of Ireland. A few *Mytili* in Sligo, a *Buccinum* in oate, Co. Westmeath, and a few fragments in Tipperary, appear to all that have been seen.

Having thus outlined the non-fossiliferous (?) Pleistocene deposits, turn to the drifts which have yielded organic remains.

Beneath 25 feet of Boulder-clay, in a river-valley, near Gort, Co. alway, sands and clays occur, according to Mr. Kinahan, containing cks, fir-cones, etc., and in Queen's County, beneath a similar accumulation, stratified clay, sand, and gravel have been proved in ring for coal. In two or three places beds of peat were present. ese infra-clay beds may be either pre- or inter-glacial.

From Donegal a drift of a totally different kind to that first entioned proceeds eastward, covering the northern counties of rry and Tyrone, picking up fragments and rock-masses, till, in the lfast and more southern districts, it forms a tenacious clay, full of ocks, sometimes glaciated, of quartz, syenite, mica-slate, porphyry, anite, and Antrim Chalk, varying from a pebble to large masses of veral tons in weight, as well as those of local origin. At Boveragh Derry the clay rises to a height of 450 feet above the sea, and ntains many fossils although of but few species. These are *Turrila terebra*, *Cyprina*, and *Leda oblonga*.

In Fermanagh, Tyrone, and Armagh, local boulders predominate, e northern rocks being scarce. In the river-valleys and those surunded by hills and high ground, the sands and gravels are often minated and interstratified. As no fossils are known from them, ey may be the remnants of interglacial deposits.

On the banks of the Lagan and the southern shores of Belfast ugh the clay has yielded to Messrs. Bryce and Hyndman a good ries of fossils, thirty-seven species in all. Of these, only two—*da oblonga* and *Trophon clathratum*—are extra-British. *Buccinum siforme* is, I think, a doubtful identification. Two specimens of an most extinct British form, *Fusus contrarius*, were also collected. e other species are added to the list of fossils from the Dublin strict, with which they closely agree.

From a stratified bed of gravel on the side of the road from Larne Glenarm, Mr. Jeffreys procured a series of fossils totally differing character from those just mentioned. Out of sixteen species of ells, not less than seven are extra-British forms. These are *Leda longa*, *Tellina proxima*, *Rhynchonella psittacea*, *Natica affinis*, *Pleurona Pingelli* (*Vahlii*), *Trophon clathratum*, and *Turritella erosa*. Such assemblage of outer British forms totally separates this Larne avel from the drifts of Belfast and Dublin, shortly to be referred to.

With the fauna of the Larne gravels I am disposed to associate that of the best known of the submarine shell-banks (the Turbot bank) lying off the mouth of Belfast Bay northwards. Several conchologists are disposed to claim the shells as recent forms; but so many are unknown in British waters that it is worth considering whether, as has been suspected, there is not here a richly-fossiliferous Post-Tertiary deposit.

I owe to Mr. Waller (Tyrone) and Mr. Stewart (Belfast) the opportunity of looking over some parcels of stuff dredged off the bank. None were live shells, but all had a porcellanous or hyaline glaze, and were devoid of colour, differing in these respects from their recent analogues.

Of 220 species listed from the bank, not more than five per cent were found living—an exceedingly small proportion. Amongst the species, all of which are small, intermixed with Celtic and southern forms, are nine or ten whose congeners now live in the northern seas; and I submit that if a deposit containing such forms as *Buccinum cyaneum*, *Cerithium niveum*, *Columbella Holböllii*, *Margarita cinerea*, *M. pusilla*, *M. undulatus*, *Natica affinis*, *Scalaria Eschrichtii*, and *Trophon clathratus*, were placed ever so little above the sea-level, instead of, as this is, 150 feet below, we should at once relegate it to some part of the Post-Tertiary series, as I propose doing in this case.

The intermixture of southern forms with those of higher latitudes does not interfere with this supposition, since they are equally present in the Killiney Drifts, the Lancashire Drifts, and in some of the Scottish Clyde beds, especially the one near Greenock. Indeed, amongst a parcel of minute shells and shelly clay from the latter place, I detected the fry or extreme young of some living Mediterranean forms,—*Conus Mediterraneus* and *Cardita trapezia*.

Forty Turbot-bank forms are still unrecorded from any British Post-Tertiary deposit, but twenty of these are well-known Crag species.

Another argument in favour of the fossiliferous nature of this bed is the fact that few, if any, of the northern species occur in the other shell-banks in the immediate neighbourhood.

South of the Mourne Mountains the calcareous gravels and clays set in near Balbriggan, and are well developed from thence southwards by Louth Finglass, up the valley of the Liffey into Kildare, and through Co. Carlow, which is covered by thick deposits, diminishing very much towards the south into Wexford, by the valley of the Slaney, and into Kilkenny by the valley of the Barrow.

On the coast the drift sets in on the summit of Killiney Hill (400 feet) in a thin bed of gravel, thickening southwards towards Bray, forming low bluffs or cliffs, passing some little way up the rivers or streams near the coast, flanking the north-west side of the greater Sugarloaf to 600 feet (shells), thence to Bray Head. From the southern side of the Promontory the deposit extends for about a mile, diminishing from a thickness of "200 feet to the level of the sea-shore" (Dr. Scouler), and passing in "a great but interrupted plain towards Wicklow" (Oldham).

In the interesting paper by Prof. Harkness[1] I find the following remarks, that I cannot agree with, and respectfully urge upon the author to reconsider them. He says, "There are several localities in Ireland where beds, having the same nature and affording precisely the same contents as the Manure Gravels of the Co. Wexford are to be found," and the type locality selected by the Professor is that one of which the Fauna is best known.

The age of the Wexford beds is a vexed question, and its relations to other localities can only be settled by the fossils.

The beds in debate extend from Arklow along the whole line of coast to Kilmore, and inland to Gorey and Enniscorthy, altogether about 40 miles long by 8 or 9 broad, and consist of fine gravels capped by Boulder-clay, full of striated stones. On the coast the clay is described by Capt. James as resting upon a deposit of rolled and waterworn pebbles, the foundation rock not being visible. The deposit had been quietly accumulated, giving time for the successive growth of layers of stony Nullipore. In the gravel (or gravelly clay, for the character of the deposit is not precisely laid down) shells abound.

From the gravels being capped by Boulder-clay Prof. Harkness appears to identify these beds with those further north, where the same general arrangement is shown in the cliffs upon the sea-shore. But this evidence is not of much value when set against the divergence of the Faunas, which I shall show presently is so well marked. It may be worth while to call to notice that at Bohernabreena, Co. Dublin, the fossiliferous drift rests upon the Corn or Limestone gravel, which in its turn overlies a stiff clay very prevalent in Dublin, Meath, and Kildare, and I am disposed to think that this stiff clay may be the equivalent of the clay which Prof. Harkness found overlying the Wexford gravels. This I need not enter upon now, as I rest my case upon the fossils of the two localities, viz. those of Wexford and those selected by the Professor; but I may notice that in Co. Wicklow, the deposits are perfectly laminated and regularly bedded, and contain entire shells, the covering bed being the Boulder-clays.

Of the 69 species of shells recorded from the Wexford beds, 52 still live in the British seas; 47 of that number being also present in the antecedent Crags, and may therefore be left out of the question. Of the others ten are high northern forms, one Japanese, four southern, and two of which the habitat (if still living) is unknown.

Now if the age of the Dublin Drifts at Howth, Glenismaule, Bohernabreena, Killiney, and Bray are the same as that of Wexford, we ought to find the Wexford fossils in some of these localities to justify the statement that the contents are the same; but the fact is that *only* one of the following extra British species (*Leda oblonga*) occurs in the Dublin beds. Three others, *Astarte borealis, Trophon clathratus*, and *Natica affinis*, are present in the equivalent West of England Drifts; but all the four species are now living on the verge of the British seas.

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[1] Geol. Mag., Vol. VI., p. 542.

Wexford fossils of species no longer living in British waters:—(Northern forms) *Astarte borealis*, *Leda hyperborea*, *Leda oblonga*, *Nucula proxima*, *Natica affinis*, *Pleurotoma Vahlii?* *Scalaria Grœlandica*, *Trophon Fabricii*, *T. clathratus*, *Volumitra* sp. (*Grœnlandica?*) (Southern forms) *Leda pusio?* *Fusus crispus?* *Nassa semistriata*, *Turritella incrassata.* (Japanese) *Nucula Cobboldiæ.* Habitat unknown, *Melampus pyramidalis*, *Fusus Bailyi* (n. sp.).[1]

For further comparison I append a list of all the shells known in the Dublin drifts, 33 in number, that the divergence of the Fauna may be more readily understood.

Still living in British waters:—*Aporrhais pes-pelicani*, *Buccinum undatum*, *Dentalium entale*, *Fusus antiquus*, *Littorina littorea*, *L. littoralis*, *Nassa incrassata*, *N. pygmea*, *Natica Alderi*, *Trochus umbilicatus*, *T. ziziphinus*, *Turritella terebra*, *Pleurotoma rufa*, *Astarte elliptica*, *Cardium edule*, *C. exiguum*, *C. tuberculatum*, *Corbula gibba*, *Cyprina islandica*, *Ostrea edulis*, *Pecten opercularis*, *P. varius*, *Psammobia ferroensis*, *P. vespertina*, *Pholas dactylus*, *Tapes decussata*, *Tellina balthica*, *Venus gallina*, *V. verrucosa.*

(Extra British) *Pleurotoma pryramidalis*, *Leda oblonga.* (Possibly British) *Loripes divaricatus, and Woodia digitaria.*[2]

To these may be added the extra British forms in the West of England drifts:—*Astarte borealis*, *A. crebricostata*, *Tellina proxima*, *Natica affinis*, *Trophon clathratum.*

Altogether 9 extra British forms, 7 northern, and 2 southern; 4 only out of the 9 being present in the Wexford deposits. We have, therefore, 18 extra British species separating the two Faunas, a large proportion out of less than 100 species all told.

The Belfast species not included in the above lists are:—

Buccinum fusiforme ?
Emarginula fissura,
Fusus contrarius,
,, *gracilis*,
Murex erinaceus,
Nassa reticulata,
Natica affinis,
Purpura lapillus,
Trochus tumidus,
Trophon truncatus,
Arca lactea,

Astarte sulcata,
,, *compressa*,
Cardium echinatum,
,, *nodosum*,
Mactra elliptica,
,, *truncata*,
Mytilus edulis,
Nucula nucleus,
Pecten maximus,
Pectunculus glycimeris,
Saxicava arctica,
Venus ovata.

I do not attach much value to the separation of clays by sands, (the arrangement of the Post-glacial drifts in Dublin Co. and in the West of England) when unsupported by other evidence, and the reader is referred to the papers by Messrs. Harkness, Hull, and others, published in this MAGAZINE, for full particulars upon these heads.

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[1] I merely indicate the existence of a shell from these gravels differing from any species known, fossil or recent. It will be described and figured shortly.

[2] Prof. Forbes adds in his list in the Mem. Geol. Survey *Nassa granulata* from Killiney. I venture to think this is *an error.*

he most recent deposits contain species all living in the present ish seas, and form the flats and lower lands at the mouths of t of the rivers and estuaries. They are frequently situated a e above high-water mark. The richest deposits for fossils are clay and sands upon which the town of Belfast stands, and its ιediate vicinity; and a raised bed, elevated about ten feet above sea, situated in a hollow of the cliff at Port Rush, Co. Antrim. fossils from the former of these localities, to the number of 200, e been listed in the Transactions of the Belfast Club by Mr. wart, who has briefly described the manner in which the fossils The most remarkable point is the large size which the *Pholas pata* attains. I have seen examples measuring nearly five inches readth, a size not reached by any recent individual, and only alleled by those from the Selsey Mud deposit.

he Port-Rush fossils have been accumulated in a bank similar to e now forming in the Channel Islands, unlike the Belfast shells, ch are in their original habitat. *Purpuræ*, *Littorinæ*, and *Patellæ* und, and the smaller genera, *Rissoa*, *Odostomia*, *Trochus*, etc., t in countless numbers.

he shell banks in Lough Foyle must have been accumulating ages. Materials derived from the banks have been used for ure for many years. As early as 1710 Archdeacon Verschoyle rs to this use of the shells, and in the Geological Report upon donderry, etc., 1843, it is stated that about 60,000 tons were oved yearly from the banks.

hese are, I believe, the principal places in which the fossils of Irish Post-Tertiary marine are to be studied.

he equivalents in time of the Wexford beds I think must be nd in some part of the older glacial series as defined by Messrs. od, Rome, and Harmer. The older Belfast and Dublin Drifts in lowest of those of the west of England; Larne and the Turbot k in the Scottish Clyde and Caithness beds; and those of the ver Belfast Clays and Port Rush in the Carse and Estuarine Clays dering the whole of Britain.

—History of the Names Cambrian and Silurian in Geology.[1]

By Prof. T. Sterry Hunt, LL.D., F.R.S.

(*Continued from p.* 395.)

2. *Middle and Lower Cambrian.*—Investigations in continental rope were, meanwhile, preparing the way for a new chapter the history of the Lower Palæozoic rocks. A series of limentary beds in Sweden and Norway had long been known abound in singular petrifactions, some of which had been amined by Linnæus, who gave to them the name of *Entolithi*. They were also studied and described by Wahlenberg d by Brongniart, the latter of whom, from two varieties the *Entomolithus paradoxus*, Linn., established in 1822

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[1] Reprinted from the "Canadian Naturalist," new series, vol. vi. no. 3, p. 294.

two genera, *Paradoxides* and *Agnostus*. In 1826 appeared a memoir by Dalman on the *Palæadæ* or so-called Trilobites; which was followed, in 1828, by his classic work on the same subject—"Ueber die Palacaden oder so-genanten Trilobiten," 4to. with six plates, Leipzig. In these works were described and figured, among many others, two genera—*Olenus*, which included *Paradoxides*, Brogn., and *Battus*, including *Agnostus* of the same author. Meanwhile, Hisinger was carefully studying the strata in which these Trilobites were found in Gothland, and in the same year (1828) published in his *Anteckningar*, or Notes on the Physical and Geognostical Structure of Norway and Sweden, a coloured geological map and section of these rocks as they occur in the county of Skaraborg; where three small circumscribed areas of nearly horizontal fossiliferous strata are shown to rest upon a floor of old crystalline rocks, in some parts granitic and in others gneissic in character. The section and map, as given by Hisinger, show the succession in the principal area to be as follows, in ascending order: 1. Granite or Gneiss; 2. Sandstone; 3. Alum-slates; 5. Orthoceratite-limestones; 4. Clay-slates. By a curious oversight the colours on the legend are wrongly arranged and wrongly numbered, as above; for in the map and section it is made clear that the succession is that just given, and that the clay-slates (4), instead of being below, are above the orthoceratite-limestones (5).

In 1837 Hisinger published his great work on the organic remains of Sweden, entitled *Lethæa Suecica* (4to. with forty-two plates). In this he gives a tabular view, in descending order, of the rock-formations, and of the various genera and species described. The rocks of the areas just noticed appear in his fourth or lowest division, under the head of *Formationes transitionis*, and are divided as follows:

a. Strata calcarea recentiora Gottlandiæ.
b. Strata schisti argillacei.
c. Strata schisti aluminaris.
d. Strata calcarea antiquiora.
e. Strata saxi arenacei.

The succession thus given was however erroneous, and probably, like the mistake in the legend of the same author's map just mentioned, the result of inadvertence, the true position of the alum-slates (*c*) being between the older limestone (*d*) and the basal sandstone (*e*). This is shown both by Hisinger's map of 1828, and by the testimony of subsequent observers. In Murchison's work on the Geology of Russia in Europe, published in 1845, there is given (page 15 et seq.) an account of his visit to this region in company with Prof. Loven, of Christiania; which, with figures of the sections, is reproduced in the different editions of *Siluria*. The hill of Kinnekulle on Lake Wener is one of the three areas of transition rocks delineated on the map of Hisinger above referred to. Resting upon a flat region of nearly vertical gneissic strata, we have, according to Murchison: 1. a Fucoidal Sandstone; 2. Alum-slates; 3. Red Orthoceratite Limestone; 4. Black Graptolitic Slates; the whole series being little over 1000 feet in thickness, and capped by erupted greenstone. Above these higher slates there are found in some parts of Gothland, other limestones with Orthoceratites, Trilobites and Corals, the newer limestone strata (*a*) of Hisinger; the whole overlaid by thin sandstone beds. These higher limestones and sandstones contain the fauna of the Wenlock and Ludlow of England; while the lower limestones and Graptolitic slates afford *Calymene Blumenbachii*, *Orthis calligramma*, and many other species common to the Bala group of North Wales. The alum-slates below these however, contained, according to Hisinger, none of the species then known in British rocks, but in their stead five species of *Olenus* and two of *Battus* (*Agnostus*).

In 1854 Angelin published his *Palæontologica Scandinavica*, part 1, *Crustacea formationis transitionis* (4to. forty-one plates), in which he divided the series of transition rocks above described by Hisinger into eight parts designated by Roman numerals, counting from the base. Of these I. was named *Regio Fucoidarum*, no organic remains other than fucoids being known therein; while the remaining seven were named from their characteristic genera of trilobites, which were as follows, in ascending order; certain letters being also used to designate the parts: II. (A) Olenus; III. (B) Conocoryphe; IV. (BC) Ceratopyge; V. (C) Asaphus; VI. (D) Trinucleus; VII. (DE) Harpes; VIII. (E) Cryptonymus. In the *Regio Olenorum* (II.) was found also the allied genus *Paradoxides*. With regard to the characteristic genus of Regio III., the name of *Conocoryphe* was proposed for it by Corda in 1847, as synonymous with Zenker's name of *Conocephalus* (*Conocephalites*) already appropriated to a genus of insects.

Meanwhile, the similar crustaceans which abound in the transition rocks of Bohemia had been studied and described by Hawle, Corda and Beyrich, when Barrande began his admirable investigations of this ancient fauna and of its stratigraphical relations. He soon found that beneath the horizon characterized by fossils of the Bala group (Llandeilo and Caradoc) there existed in Bohemia a series of strata distinguished by a remarkable fauna, entirely distinct from anything known in Great Britain, but closely allied to that of the alum-slates of Scandinavia, corresponding to Regiones II. and III. of Angelin. To this he gave the name of the first or primordial fauna, and to the rocks yielding it that of the Primordial Zone. Resting upon the old gneisses of Bohemia appears a series of crystalline schists designated by Barrande as *Etage A*, overlaid by a series of sandstones and conglomerates, *Etage B*, upon which repose the fossiliferous argillites of the Primordial Zone or *Etage C*. The rocks of the Etages A and B were by Barrande regarded as azoic, but in 1861 Fritsch of Prague, after a careful search, discovered in certain thin-bedded sandstones of B the traces of filled-up vertical double tubes, which, according to Salter (Mem. Geol. Surv., vol. iii. p. 243), are probably the marks of Annelides, and are identical with those found in the rocks of the Bangor or Longmynd group in Great Britain; which will be shown to belong to the Primordial Zone. It is, therefore, probable that *Etage B*, which apparently corresponds to the Regio Fucoidarum or basal sandstone of Scandinavia, should itself be included in the Primordial Zone. It may here be noticed that it is in the crystalline schists of (A) that Gumbel has found *Eozoon Bavaricum.* To *Etage C* in Bohemia, Barrande assigns a thickness of about 1200 feet, and to this his first fauna is confined, while in the succeeding divisions he distinguished a second and a third. The second fauna, which characterizes *Etage D,* corresponds to that of the Bala group; while the third fauna, belonging to *Etages E, F, G* and *H,* is that of the May Hill, Wenlock and Ludlow formations of Great Britain.

This classification of the ancient Bohemian faunas was first set forth by Barrande in 1846, in his *Notice Preliminaire,* in which he declared that the first fauna was below the base of the Llandeilo of Murchison, unknown in Great Britain, and, moreover, "new and independent in relation to the two Silurian faunas (his second and third) already established in England." This opinion he reiterated in 1859. These three divisions form in Bohemia an apparently continuous series, and being connected with each other by some common species, Barrande was led to look upon the whole as forming a single stratigraphical system; and finally to assert that these three independent faunas "form by their union an indivisible triad which is the Silurian system." (Bul. Soc. Geol. de Fr., ser. II. vol. xvi. pp. 529-545.) Already, in 1852, in his magnificent work on the Silurian System of Bohemia, Barrande had given to the strata characterized by his first fauna the name of Primordial Silurian. It is difficult to assign any just reason for thus annexing to the Silurian—already augmented by the whole Upper Cambrian or Bala group of Sedgwick (Llandeilo and Caradoc)—a great series of fossiliferous rocks lying below the base of the Llandeilo, and unsuspected by the author of the *Silurian System;* who persistently claimed the Llandeilo beds, with their characteristic second fauna, as marking the dawn of organic life.

Up to this time the primordial Palæozoic fauna of Bohemia and of Scandinavia was, as we have said, unknown in Great Britain. The few organic remains mentioned by Sedgwick in 1835 as occurring in the region occupied by his Lower and Middle Cambrian, on Snowdon, were found to belong to Bala beds, which there rest upon the older rocks: nor was it until 1845 that Mr. Davis found in the Middle Cambrian remains of Lingula. In 1846 Sedgwick, in company with Mr. Davis, re-examined these rocks, and in December of the same year described the Lingula-beds as overlaid by the Tremadoc slates and occupying a well-defined horizon in Caernarvon and Merionethshire, beneath the great mass of the Upper Cambrian rocks. (Geol. Journ. vol. ii. p. 75; vol. iii. p. 139.) Sedgwick, at the same time, noticed about this horizon certain Graptolites and an *Asaphus,* which were supposed to belong to the Tremadoc slates, but have since been declared by Salter to pertain to the Arenig or Lower Llandeilo beds, the base of the Upper Cambrian. (Mem. Geol. Surv., vol. iii. p. 257, and Decade II.)

This discovery of the Lingula-flags, as they were then named, and fixing by Sedgwick of their geological horizon, was at once wed by a careful examination of them by the Government Surrs, and in 1847 Selwyn detected in the Lingula-flags, near elly, in Merionethshire, the remains of two crustacean forms, ne a Phyllopod, which has received the name of *Hymenocaris cauda*, Salter, and the other a trilobite which was described by r in 1849 as *Olenus micrurus*. (Geol. Survey, Decade II.) A es of *Paradoxides*, apparently identical with *P. Forchhammeri* of len, was also about this time recognized among specimens supl to be from the same horizon. It has since been described as *icksii*, and found to belong to the basal beds of the Lingula-,—the Menevian group.

on the flanks of the Malvern Hills there are found resting upon ncient crystalline rocks of the region, and overlaid by the Penrus beds of the May Hill Sandstone (originally called Caradoc urchison) a series of fossiliferous beds. These consist in their st part of about 600 feet of greenish sandstone, which have yielded an *Obolella* and *Serpulites*, and are overlaid by 500 feet ack schists. In these, in 1842, Prof. John Phillips found the ins of Trilobites, which he subsequently described, in 1848, as species of *Olenus*. (Mem. Geol. Survey, vol. ii. part 1, p. 55.) e black shales, which had not at that time furnished any organic ins, were by Murchison in his *Silurian System* (p. 416) in 1839 ared to the supposed Passage-beds in Caermarthenshire between landeilo and the Cambrian (Bala) rocks; which, as we have were newer and not older strata than the Llandeilo-flags. From lithological characters, and their relations to the Pentamerus these lower fossiliferous strata of Malvern were subsequently red by the Government geologists to the horizon of the Caradoc r or Bala group; nor was it until 1851, that their true geoal age and significance were made known. In that year Bar, fresh from the study of the older rocks of the continent, came gland for the purpose of comparing the British fossils with of the Primordial Zone, which he had established in Bohemia Scandinavia, and which he at once recognized in the Lingula- of Sedgwick and in the black schists at Malvern; both of which characterized by the presence of the genus *Olenus*, and were red to the horizon of his Etage C. This important conclusion announced by Salter to the British Association at Belfast in . (Rep. Brit. Assoc., Abstracts, p. 56, and Bull. Soc. Geol. de ser. II. vol. xvi. p. 537.) Since that time the progress of ingation in the Middle and Lower Cambrian rocks of Wales has n a fauna the importance and richness of which has increased year to year.

e palæontological studies of Salter, while they confirmed the ordial character of the whole of the great mass of strata which up the Middle Cambrian or Ffestiniog group of Sedgwick isting of the Lingula-flags and the Tremadoc slates), led him opose several sub-divisions. Thus he distinguished on palæonical grounds between the Upper and Lower Tremadoc slates, and for like reasons divided the Lingula-flags into a lower and an upper portion. For the discussion of these distinctions the reader is referred to the Memoirs of the Geol. Survey (vol. iii. pp. 240-257.) Subsequent researches led to the division of the original Lingula-flags into three parts, an upper and a middle, to which the names of Dolgelly and Maentwrog were given by Mr. Belt, and a third consisting of the basal beds, which were separated in 1865, by Salter and Hicks, with the designation of Menevian, derived from the ancient Roman name of St. Davids in Pembrokeshire. It was here that, in 1862, Salter found *Paradoxides* with *Agnostus* and *Lingula* in fine black shales at the base of the Lingula-flags, resting conformably on the green and purple grits of the Lower Cambrian or Harlech beds. The locality was afterwards carefully studied by Hicks, and it was soon made apparent that the genus *Paradoxides*, both here and in North Wales, was confined to a horizon below the great mass of the Lingula-flags; which, on the contrary, are characterized by numerous species of *Olenus*. These lower or Menevian beds are hence regarded by Salter as equivalent to the lowest portion of the *Etage C* of Barrande.

Beneath these Menevian beds there lies, in apparent conformity, the great Lower Cambrian series, frequently called the bottom or basement rocks by the Government surveyors; represented in North Wales by the Harlech grits, and in South Wales, near St. Davids, by a similar series of green and purple sandstones, considered by Murchison, and others, as the equivalent of the Harlech rocks. They were still supposed to be unfossiliferous until in June 1867, Salter and Hicks announced the discovery in the red beds of this lower series, at St. Davids, of a *Lingulella*, very like *L. ferruginea* of the Menevian. (Geol. Journ., vol. xxiii. p. 339; Siluria, 4th ed. p. 550.) This led to a farther examination of these Lower Cambrian beds, which has resulted in the discovery in them of a fauna distinctly primordial in type, and linked to the Menevian by the presence of several identical fossils; but in many respects distinct, and marking a lower fossiliferous horizon than anything known in Bohemia or in Scandinavia.

The first announcement of these important results was made to the British Association at Norwich in 1868. Further details were, however, laid before the Geological Society in May 1871, by Messrs. Harkness and Hicks, whose paper on the Ancient Rocks of St. David's Promontory appears in the Geological Journal for November, 1871. (vol. xxviii. p. 384.) The Cambrian sediments here rest upon an older series of crystalline stratified rocks, described by the Geological Surveyors as syenite and greenstone, having a north-west strike. Lying unconformably upon these, and with a north-east strike, we have the following series, in ascending order: 1. quartzose conglomerate, 60 feet; 2. greenish flaggy sandstones, 460 feet; 3. red flags or slaty beds, 50 feet, containing *Lingulella ferruginea*, besides a larger species, *Discina*, and *Leperditia Cambrensis*; 4. purple and greenish sandstones, 1000 feet; 5. yellowish grey sandstones, flags and shales, 150 feet, with *Plutonia, Conocoryphe, Microdiscus*

Agnostus, Theca and *Protospongia*; 6. grey, purple, and red flaggy sandstones, with most of the above genera, 1500 feet; 7. grey flaggy beds, 150 feet, with *Paradoxides*; 8. true Menevian beds, richly fossiliferous, 500 feet. The latter are the probable equivalent of the base of Barrande's *Etage C*, and at St. Davids are conformably overlaid by the Lingula-flags; beneath which we have, including the Menevian, a conformable series of 3370 feet of uncrystalline sediments, fossiliferous nearly to the base, and holding a well-marked fauna distinct from anything hitherto known in Great Britain or elsewhere.

The Menevian beds are connected with the underlying strata by the presence of *Lingulella ferruginea, Discina pileolus,* and *Obolella sagittatis,* which extend through the whole series; and also by the genus *Paradoxides,* four species of which occur in these lower strata; from which the genus *Olenus,* which characterizes the Lingula-flags, seems to be absent. To a large tuberculated trilobite of a new genus found in these lowest rocks the name of *Plutonia Sedgwickii* has been given. Hicks has proposed to unite the Menevian with the Harlech beds, and to make the summit of the former the dividing line between the Lower and Middle Cambrian, a suggestion which has been adopted by Lyell. (Proc. Brit. Assoc. for 1868, p. 68, and Lyell, Student's Manual of Geology, pp. 466–469.)

Both Phillips and Lyell give the name of Upper Cambrian to the Lingula-flags and the Tremadoc slates, which together constitute the Middle Cambrian of Sedgwick, and concede the title of Lower Silurian to the Bala group or Upper Cambrian of Sedgwick. The same view is adopted by Linnarsson in Sweden, who places the line between Cambrian and Silurian at the base of the Llandeilo or the second fauna. It was by following these authorities that I, inadvertently, in my address to the American Association for the Advancement of Science in August, 1871, gave this horizon as the original division between Cambrian and Silurian. The reader of the first part of this paper will see with how much justice Sedgwick claims for the Cambrian the whole of the fossiliferous rocks of Wales *beneath* the base of the May Hill Sandstone, including both the first and the second fauna. I cannot but agree with the late Henry Darwin Rogers, who, in 1856, reserved the designation of "the true European Silurian" for the rocks *above* this horizon. (Keith Johnston's Physical Atlas, 2nd ed.)

The Lingula-flags and Tremadoc slates have been made the subject of careful stratigraphical and palæontological studies by the Geological Survey, the results of which are set forth by Ramsay and Salter in the third volume of the Memoirs of the Geological Survey, published in 1866, and also, more concisely, in the Anniversary Address by the former to the Geological Society in 1863. (Geol. Journ. vol. xix. p. xviii.) The Lingula-flags (with the underlying Menevian, which resembles them lithologically) rest in apparent conformity upon the purple Harlech rocks both in Pembrokeshire and in Merionethshire, where the latter appear on the great Merioneth anticlinal, long since pointed out by Sedgwick. The Lingula-flags,

[illegible]

[illegible] it may be conceived [illegible] in a region where the period corresponding to [illegible] geological series was marked by comparatively small [illegible] of sediment upon an [illegible] subjected to no great movements.

This contrast is strikingly seen between the conformable series of less than 2000 feet of strata which in Scandinavia are characterized by the first three Palæozoic faunas (Cambrian and Silurian), and the repeatedly broken and discordant succession of more than 30,000 feet of sediments,[1] which in Wales are their palæontological equivalents. It must, however, be considered that in regions of small accumulation where, as in Scandinavia, the formations are thin, there may be lost or unrepresented zoological epochs whose place in the series is marked by no stratigraphical break. In such comparatively stable regions, movements of the surface sufficient to cause the exclusion, or the disappearance by removal, of the small thickness of strata corresponding to an epoch, may take place without any conspicuous marks of stratigraphical discordance.

The attempt to establish geological divisions or horizons upon stratigraphical or palæontological breaks must always prove fallacious. From the nature of things, these, whether due to non-deposition or to subsequent removal of deposits, must be local; and we can say, confidently, that there exists no break in life or in sedimentation which is not somewhere filled up and represented by a continuous and conformable succession. While we may define one period as characterized by the presence of a certain fauna, which, in a succeeding epoch, is replaced by a different one, there will always be found, in some part of their geographical distribution, a region where the two faunas commingle, and where the gradual disappearance of the old before the new may be studied. The division of our stratified rocks into systems is therefore unphilosophical, if we assign any definite or precise boundaries or limitations to these. It was long since said by Sedgwick with regard to the whole succession of life through geologic time,—that all belongs to one great *systema naturæ*. (Philos. Mag., IV. vol. viii. p. 359.)

(To be continued in our next Number.)

VI.—REVIEW OF THE CONTRIBUTIONS TO FOSSIL BOTANY PUBLISHED IN BRITAIN IN 1872.

By WILLIAM CARRUTHERS, F.R.S.

THE following papers have been published:—

BINNEY, E. W. On *Stauropteris Oldhamia*, sp. nov. Monthly Microsc. Journ., vol. vii., March, 1872, pp. 132, 133.

This name is proposed for a fossil from Oldham resembling *Psaronius Zeidleri*, Corda; the author records the discovery of specimens of *Zygopteris*, and his conviction that Cotta's *Medullosa elegans* is "merely the rachis of a fern, or a plant allied to one."

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[1] The Longmynd rocks in Shropshire are alone estimated at 20,000 feet; but their supposed equivalents, the Harlech rocks of Pembrokeshire, have a measured thickness of 3,300, while the Llanberris and Harlech rocks together, in North Wales, equal from 4.000 to 7,000 feet, and the Lingula-flags and Tremadoc slates, united, about 7,000 feet. The Bala group in the Berwyns exceeds 12,000 feet, and the proper Silurian, from the base of the Upper Llandovery or May Hill Sandstone, attains from 5,000 to 6,000 feet; so that the aggregate of 30,000 feet may be considered below the truth. [Mem. Geol. Survey, vol. iii. part 2, pp. 72, 222, and Siluria, 4th ed. p. 185.]

BINNEY, E. W. The Flora of the Carboniferous Strata. Part III. Palæont. Soc., pp. 63 96, pl. xiii.–xviii.

This part is devoted to drawings and descriptions of specimens of *Lepidodendron Harcourtii*, *Sigillaria vascularis*, and *Halonia regularis*. The author considers the last fossil to be the roots of *Lepidodendron*.

CARRUTHERS, W. Notes on some Fossil Plants. GEOL. MAG., Vol. IX. pp. 49 59, Pl. II.

The author gives—1. A restoration of a frond of *Palæopteris Hibernica*, Schimper, from Kiltorkan, Ireland, and, placing it in the *Hymenophylleæ*, investigates its relation to existing forms. 2. Figures and descriptions of Hymenophylleous sporangia from the Coal-measures. 3. A short notice of *Osmundites Dowkeri*, Carr., from the Eocene beds at Herne Bay. 4. An investigation of *Antholithes* of the Coal-measures, in which it is shown that their fruit is *Cardiocarpum*, and that they were probably the inflorescences of *Gymnosperms*. Two species are described. 5. Specimens of Coniferous Wood from the Coal-measures and the Wealden are figured and described. And 6. *Pothocites Grantoni*, Paterson, a monocotyledonous inflorescence from the Coal-measures is figured.

——— On the Tree-ferns of the Coal-measures, and their Affinities with Existing Forms. Abstract. GEOL. MAG. Vol. IX. pp. 465–467. Journal of Botany, vol. x. pp. 279 281.

The abstract of paper read to the British Association, in which the ferns are grouped in three divisions, severally represented by *Caulopteris*, *Tubicaulis*, and *Stemmatopteris*, the stem of the last being of a type now extinct, though the fronds and inflorescence were probably the same as those of some existing arborescent *Polypodiaceæ*.

——— Notes on Fossil Plants from Queensland, Australia. Quart. Journ. Geol. Soc., vol. xxviii. pp. 350–356, pl. xxvi. and xxvii.

Contains an account of Fossils collected by Mr. R. Daintree, belonging to Devonian and Oolitic formations, with figures and descriptions of three new species.

——— On the History, Histological Structure, and Affinities of *Nematophycus Logani*, Carr. (*Prototaxites Logani*, Dawson), an Alga of Devonian Age. Monthly Microscopical Journal, vol. viii., Oct., 1872, pp. 160–172, pl. xxxi. and xxxii.

The author points out that the same fossil had been described by Dr. Dawson under the two names *Prototaxites Logani* and *Nematoxylon crassum*, and had been referred by him to *Taxineæ* from its microscopic structure. The author shows that the fossil is not made up of wood-cells, but entirely consists of cellular filaments of two sizes interwoven irregularly into a felted mass, and that its affinities are with the cellular Cryptogams. Reasons are given for placing it among the filamentous Chlorosperms, and the name is changed, because of the error implied in both generic names applied by Dr. Dawson, into *Nematophycus*.

——— On the Structure of the Stems of the Arborescent Lycopodiaceæ of the Coal-measures.—IV. on a Leaf-bearing branch of a species of *Lepidodendron*. Monthly Microsc. Journ., vol. vii. February, 1872, pp. 50–54, pl. vii. and viii.

The minute structure of a small stem and of the leaf bases is figured and described, and the bearing the specimen has on the characters which separate *Lepidophloios* from *Lepidodendron* is investigated.

DICKIE, GEORGE. Notice of a Diatomaceous Deposit. Trans. Bot. Soc., Edinburgh, vol. xi. p. 394

An enumeration of 40 species of *Diatomaceæ* found in a peat-bog at Methlic, Aberdeenshire.

DYER, W. T. THISELTON. On some Coniferous Remains from the Lithographic Stone of Solenhofen. GEOL. MAG., Vol. IX. pp. 150–153, and 193–196.

The author describes separate scales of a cone under the name *Araucarites Haberleinii*, Dyer, and investigates the different Coniferous branches found at Solenhofen, referring them to three genera—*Pinites*, 1 species; *Athrotaxites*, 5 species; and *Condylites*, 1 species.

——— On some Fossil Wood from the Lower Eocene. GEOL. MAG., Vol. IX. pp. 240–243. Pl. VI.

The author describes the occurrence in this specimen of wood, of cells in the interior of the ducts, and gives the received explanation of their origin.

EER, OSWALD. On the Carboniferous Flora of Bear Island. Quart. Journ. Geol. Soc., vol. xxviii. pp. 161–169.

The author considers that the fossil plants from Bear Island are more nearly lated to the Carboniferous than to the Devonian, and he consequently places them ıd the fossils of Yellow Sandstones of Ireland, which he believes to be of the me age, as the fundamental series of the Lower Carboniferous system, under the ıme of the Ursa stage.

——— On *Cyclostigma*, *Lepidodendron*, and *Knorria*, from Kiltorkan. Quart. Journ. Geol. Soc., vol. xxviii. pp. 169–172, pl. iv. Abstract. GEOL. MAG., Vol. IX. p. 134.

Prof. Heer maintains the specific distinctness of *Cyclostigma Kiltorkense*, [aught., *C. minutum*, Haught., *Knorria acicularis*, Göpp., and *Lepidodendron 'eltheimianum*, Sternb., all from Kiltorkan, which I had maintained to be agments of the same species. He figures and describes his species.

[IGGINS, Rev. H. H. On some specimens supposed to be *Pycnophyllum* in the Ravenshead collection of Fossils, Free Public Museum, Liverpool. Proceedings Liverpool Geol. Soc. 1872, pp. 71–75, with plate.

The curious stems figured and described by the author are amorphous casts of :rn-stems of the *Caulopteris* type.

[ACLOSKIE, Rev. Dr. On the Silicified Wood of Lough Neagh, with Notes on the Structure of Coniferous Wood. Abstract. Journ. Bot., vol. x. pp. 93–95.

The author describes *Cupressoxylon Pritchardi*, Kr., and gives an account of the onditions under which it occurs.

[ARRAT, F. P. On the Fossil Ferns in the Ravenshead Collection. Proceedings Liverpool Geol. Soc. 1872, pp. 4-16. Plates 1-13.

The author enumerates 62 species, 9 of which he considers undescribed, and he ives them names. The figures and descriptions are scarcely sufficient for indeendent investigators to determine the characters which distinguish them from lready described species.

'EACH, C. W. On Fossil Plants from the Coal-fields of Slamannan, Falkirk, Dreside, Tillicoultry, etc. Abstract. Trans. Edin. Bot. Soc. vol. xi. p. 342.

An enumeration of some of the more remarkable fossils the author collected in ıe localities specified.

——— On a Cone of *Flemingites gracilis* attached to its stem. Abstract. Trans. Edin. Bot. Soc. vol. xi. p. 356.

The author describes the specimens he had found.

VILLIAMSON, W.C. On the Structure of the *Dictyoxylons* of the Coal-measures. Abstract. Report Brit. Assoc. 1871, pp. 111, 112.

Three species are shortly described—*Dictyoxylon Oldhamium*, *D. radicans*, and *D. Grievii.*

——— On the Organization of the Fossil Plants of the Coal-measures. Part i. CALAMITES. Phil. Trans. vol. clxi. pp. 477–510. pl. xxiii.-xxix.

The author figures and describes in detail the specimens in his cabinet, and roposes to divide the *Calamites* into two generic groups, retaining *Calamites* for he stems which have no infranodal canals, as indicated by the absence of verticils f round or oblong scars, and adopting *Calamopitus* for those which have such anals.

——— On the Organization of the Fossil Plants of the Coal-measures. Part ii. LYCOPODIACEÆ: *Lepidodendra* and *Sigillariæ*. Phil. Trans. vol. clxii. pp. 197–240, pl. xxiv.-xxxi.

The author figures and describes in detail sections of *Lepidodendron*, *Ulodendron*, *Halonia*, *Diploxylon*, and *Sigillaria*. He considers *Anabathra* of Witham to be he same as *Diploxylon*, and among the stems described he distinguishes four pecies to which he gives specific names. He considers the whole belong to the ame group, and that they are Lycopodiaceous.

——— Notice of further Researches on the Fossil Plants of the Coal-measures, in a Letter to Dr. Sharpey, Sec. R.S. Proc. Roy. Soc. vol. xx. pp. 95, 96.

The author records the progress of his investigations into the nature of a *Lepidodendroid* plant and its fruit from Burntisland, and of an *Asterophyllites* from Lancashire, which he proposes to submit to the Society speedily.

——— On the Organization of the Fossil Plants of the Coal-measures. Part iii. LYCOPODIACEÆ. Abstract. Proc. Roy. Soc. vol. xx. pp. 199–203.

A plant from Burntisland—*Lepidophloios brevifolium*, Williamson—is described at length, and reasons are given for uniting the genera *Diploxylon*, *Anabathra*, *Lomatophloios* and *Leptoxylon*.

WILLIAMSON, W. C. Notice of further Researches among the Plants of the Coal-measures. Proc. Roy. Soc. vol. xx. pp. 435-438.

The author refers to investigations which induce him to propose a new genus *Astromyelon* for Calamite-stems already figured by him, to change his *Dictyoxylon radicans* into *Amyelon radicans*, and which show that *Asterophyllites* is not the branch of a *Calamite*. He also refers to stems of petioles from Burntisland, on which he proposes to found two new genera, *Arpexylon* and *Edraxylon*, as well as to the occurrence of *Zygopteris Lacattii* in Lancashire.

Synopsis of the Genera and Species described in the foregoing papers:

ALGÆ.

Nematophycus Logani, Carr., Month. Micro. Journ. 1872, p. 160, plate xxxi. and xxxii. *Devonian.* Canada.

FILICES.

Amyelon radicans, Williamson, Proc. Royal Soc., vol. xx. p. 438.

Arpexylon, Williamson, Proc. Roy. Soc., vol. xx. p. 438.

Cyclopteris cuneata, Carr. Quart. Journ. Geol. Soc., vol. xxviii. p. 355, pl. xxvii. f. 5. *Oolite.* Queensland.

Edraxylon, Williamson, Proc. Roy. Soc., vol. xx. p. 438.

Medullosa elegans, Cotta; Binney, Mon. Micro. Journ., vol. vii. p. 133. *Carboniferous.* Oldham.

Nephropteris denticulata, Marrat, Liverpool Geol. Soc. Proc., 1872, p. 11. *Carboniferous.* Ravenshead.

N. triangularis, Marrat, l. c. p. 11, pl. i. fig. 1. *Carboniferous.* Ravenshead.

Odontopteris neuropteroides, Marrat, Liverpool Geol. Soc. Proc. 1872, p. 14, pl. vii., f. 1 and 2. *Carboniferous.* Ravenshead.

Osmundites Dowkeri, Carr., GEOL. MAG. Vol. IX., p. 52, Pl. II. Figs. 8 and 9. *Tertiary.* Kent.

Palæopteris Hibernica, Sch.; Carruthers, GEOL. MAG. Vol. IX., p. 49, Pl. II. Figs. 1—4. *Devonian.* Kiltorkan, Ireland.

Pecopteris odontopteroides, Morris; Carruthers, Quart. Journ. Geol. Soc., vol. xxviii. p. 355; pl. xxvii. f. 2 and 3. *Oolite.* Queensland.

Sphenopteris coriacea, Marrat, Liverpool Geol. Soc. Proc. 1872, p. 5; pl. ix. f. 1 and 2. There are no characters given to distinguish this from *S. Hibberti*, Lindl. and Hutt. *Carboniferous.* Ravenshead.

Sphenopteris elongata, Carr., Quart. Journ. Geol. Soc., vol. xxviii. p. 355; pl. xxvii. f. 1. *Oolite.* Queensland.

S. Footneri, Marrat, l. c. p. 8; pl. viii. f. 2, 3. *Carboniferous.* Ravenshead.

S. multifida, Marrat, l. c. p. 9; pl. v. f. 4. *Carboniferous.* Ravenshead.

S. obliqua, Marrat, l. c. p. 6; pl. ix. f. 3. *Carboniferous.* Ravenshead.

S. plumula, Marrat, l. c. p. 6; pl. v. f. 3. *Carboniferous.* Ravenshead.

S. pulchra, Marrat, l. c. p. 8; pl. viii. f. 1 = *Pecopteris repanda*, Lindl. and Hutt. *Carboniferous.* Ravenshead.

Stauropteris Oldhamia, Binney, Mon. Micr. Journ., vol. vii. p. 132. *Carboniferous.* Oldham.

Tæniopteris Daintreei, M'Coy; Carruthers, Quart. Journ. Geol. Soc., vol. xxviii. p 355; pl. xxvii. f. 6. *Oolite.* Queensland.

EQUISETACEÆ.

Astromyelon, Williamson, Proc. Royal Soc., vol. xx. p. 435.

Calamites, Williamson, Phil. Trans., vol. clxi. p. 477-510; pl. xxiii.-xxix.

Calamopitus, Williamson, l. c.

LYCOPODIACEÆ.

Cyclostigma Kiltorkense, Haught.; Heer, Quart. Journ. Geol. Soc., p. 169; pl. iv. f. 4, 5. *Devonian.* Kiltorkan.

C. minutum, Haught.; Heer, l. c. p. 169; pl. iv. f. 2, 3. *Devonian.* Kiltorkan.

Diploxylon cycadeoideum, Corda; Williamson, Phil. Trans. vol. clxii. p. 239, pl. xxvi.-xxviii.

D. cylindricum, Williamson, l. c., pl. xxviii. fig. 33, 34.

Diploxylon stigmarioideum, Williamson, l. c. p. 239.
D. vasculare, Williamson, l. c. pl. xxv. fig. 8–11.
avularia, Williamson, Phil. Trans. vol. clxii. p. 210, pl. xxvii. and xxviii. fig. 29–32.
Knorria acicularis, Göpp. var. *Bailyana*; Heer, Quart. Journ. Geol. Soc., vol. xxviii. p. 170; pl. iv. f. 6. *Devonian*. Kiltorkan.
Lepidodendron, — structure of a leaf-bearing branch, Mon. Micr. Journ., vol. vii. 1872, p. 50, pl. vii. and viii.
Lepidodendron nothum, Unger; Carruthers, Quart. Journ. Geol. Soc., vol. xxviii. p. 353, pl. xxvi. *Devonian*. Queensland.
L. Veltheimianum, Sternb.; Heer, Quart. Journ. Geol. Soc., vol. xxviii. p. 171, pl. iv. f. 1. *Devonian*. Kiltorkan.
L. selaginoides, Sternb.; Williamson, Phil. Trans. vol. clxii. p. 199, pl. xxiv. and xxv.
Lepidophloios brevifolium, Williamson, Proc. Roy. Soc., vol. xx. p. 203. *Carboniferous*. Burntisland.
Ulodendron, Williamson, Phil. Trans., vol. clxii. p. 209, pl. xxvi.–xxviii. figs. 24–28.

NIFERÆ.

Athrotaxites princeps, Ung.; Dyer, GEOL. MAG. Vol. IX. p. 194, Pl. V. Fig. 2. *Upper Oolite*. Solenhofen.
A. Frischmanni, Ung.; Dyer, GEOL. MAG. Vol. IX. p. 194, Pl. V. Fig. 3. *Upper Oolite*. Solenhofen.
A. (?) *laxus*, Dyer, l. c. p. 195, Pl. V. Fig. 6. *Upper Oolite*. Solenhofen.
A. longirameus, Dyer, l. c. p. 195, Pl. V. Fig. 5. *Upper Oolite*. Solenhofen.
A. lycopodioides, Ung., l. c. p. 194, Pl. V. Fig. 4. *Upper Oolite*. Solenhofen.
Araucarites Häberleinii, Dyer, GEOL. MAG. Vol. IX. p. 150, Fig. 1–3. *Upper Oolite*. Solenhofen.
Condylites squamatus, Dyer, GEOL. MAG., Vol. IX. p. 195. Pl. V. Fig. 7. *Upper Oolite*. Solenhofen.
Cupressoxylon Pritchardi, Kr.; Macloskie, Journ. Bot. vol. x. p. 93. *Tertiary*. Lough Neagh.
Pinites Solenhofenensis, Dyer, GEOL. MAG. Vol. IX. p. 193, Pl. V. Fig. 1. *Upper Oolite*. Solenhofen.
Pinites Withami, Lindl. and Hutt.; Carruthers, GEOL. MAG. Vol. IX. p. 58, Fig. 4. *Carboniferous*. Edinburgh.
Prototaxites Logani, Dawson, see *Nematophycus*.

MNOSPERMÆ?

Antholithes, Brongn.; Carruthers, GEOL. MAG. Vol. IX. p. 52.
Cardiocarpon, Brongn.; Carruthers, GEOL. MAG. Vol. IX. p. 52.
Cardiocarpum australe, Carr., Quart. Journ. Geol. Soc., vol. xxviii. p. 356; pl. xxvii. f. 4. *Oolite*. Queensland.
C. Lindleyi, Carr., l. c. p. 56; f. 1 and 2. *Carboniferous*. Falkirk.
C. anomalum, Carr., l. c. p. 57; f. 3. *Carboniferous*. Coalbrook Dale.

NOCOTYLEDONES.

Pothocites Grantoni, Paterson; Carruthers, GEOL. MAG. Vol. IX. p. 58, Fig. 6. *Carboniferous*. Edinburgh.

NOTICES OF MEMOIRS.

THE MAMMALIA OF EUROPE AT THE CLOSE OF THE MIOCENE EPOCH.

NSIDÉRATIONS SUR LES MAMMIFÈRES QUI ONT VÉCU EN EUROPE A LA FIN DE L'EPOQUE MIOCENE. par PROF. ALBERT GAUDRY, (Extrait du Mémoire Intitulé: Animaux fossiles du Mont Léberon, Vaucluse. Paris, 1873.)

ROM the study of the remains of the fossil Mammalia of Pikermi, M. Gaudry considers it more probable that the successive ecies occurring at different geological ages have been derived from ch other, than that they were created independently. His conclusions are based upon the discovery of numerous intermediate forms between genera which have heretofore been considered as very distinct: for example, an ape intermediate between the *Semnopithecus* and *Macacus*; a carnivore between the *Hyæna* and Civet; a pachyderm between the *Anchitherium* and Horse, a ruminant between the Goat and Antelope. The comparison of fossils from other localities has afforded similar results. With the view of combating the opinions opposed to him, M. Gaudry has studied the fossil Miocene Fauna of Mont Léberon, and has arranged his observations under the following headings:—

1.—The close of the Miocene Period was characterized by a great development of Herbivora.

2.—The Miocene Mammalia prove that the types of the higher forms have been more variable than the lower.

3.—An examination of the Mammalia proves that the Upper Miocene of Europe can be divided into two stages.

4.—The study of the Miocene Mammalia supports the hypothesis that the separation of the Faunas has been only the result of the local displacement of the Faunas.

5.—On the analogous forms of Mammalia which have preceded and followed those of the Upper Miocene.

6.—On the distinction of races and species of some Mammalia at the close of the Miocene Period.

I.—The study of the ancient animals of Vaucluse shows that the *Dinotherium* was accompanied by a large wild boar, two species of *Rhinoceros* and the *Helladotherium*, the most majestic of all the ruminants which inhabited Europe. The plains were covered with herds of the *Hipparion*, of Gazelles with harp-like horns, together with a *Tragocerus* related to the antelopes, a *Cervus* (*C. Matheronis*), also a large tortoise and some smaller species. Few Carnivora troubled the peaceful pastures of the Herbivora, the remains of *Machairodus*, *Hyæna*, and *Ictitherium* having only rarely been met with. The following list shows that the quadrupeds of Léberon were, in all probability, contemporaneous with those of Pikermi (Greece), Baltavar (Hungary), and Concud (Spain).

Mont Léberon (Vaucluse).	Pikermi (Greece).	Baltavar (Hungary).	Concud (Spain).
Machairodus cultridens	x	x	
Hyæna eximia	x	x	x
Ictitherium hipparionum	x		
——— *Orbignyi*?	x		
Dinotherium giganteum	x	Dinotherium	
Acerotherium incisivum?	x?		
Rhinoceros Schleiermacheri	var		
Hipparion gracile	x	x	x
Sus major	*S. erymanthius*		
Helladotherium Duvernoyi	x	x	
Tragocerus amaltheus	x	. x	x
Cervus Matheronis	...	...	x
Gazella deperdita	x	x	x

The above list shows the great development of Herbivora, a characteristic feature of the close of the Miocene period. During the Calcaire Grossier and Gypsum period of the Paris Basin, the pachyderms predominated; the *Lophiodon*, *Chœropotamus*, *Hyracotherium*, *Palæotherium*, *Anchilophus*, and *Anoplotherium*. The most herbivorous animals were the *Xiphodon*, *Dichodon*, and *Amphimeryx*, so near the pachyderms that some Naturalists range them in the same order. Although found in the Lower and Middle Miocene with some modifications in their dental structure, and the more or less anchylosed character of the metatarsal bones, as in the *Gelocus*, *Dremotherium*, and *Anchitherium*, it was in the Upper Miocene that the Herbivora were most largely developed. The Giraffe and *Helladotherium* attained a size unknown among preceding ruminants, the Antelopes and Stags were of more varied forms, the *Hipparion* succeeded the *Anchitherium*. M. Gaudry does not consider the prairies resembled those of northern Europe at present, for, from the character of the dentition of the animals, the grasses did not form an important part of the vegetation with which the country was then covered. During the Pliocene, Quaternary, and present (or Modern) periods the ruminants, as well as the *Solipedes* (or *Equidæ*), were very numerous in Europe, and the prairies were more extended. The evolution of the Carnivora followed that of the Herbivora. At the commencement of the Eocene period the beasts of prey were of small size and not numerous; the *Hyænodon* and *Pterodon* did not exceed the size of the wolf. Soon after appeared the great *Amphicyon*, in character intermediate between the bear and the dog, inclining one to the belief that they were probably omnivorous in habit, and devoured more dead flesh than living prey. It was at the close of the Miocene period that the Carnivora arrived at their apogee, and were represented by two extreme types, the *Hyæna* and the *Machairodus*.

II.—Palæontologists have often supposed that a great difference existed in the variation of the higher as contrasted with the lower types of organic beings. Indeed it has been considered that many of the Miocene Mollusca, as well as a certain number of the Eocene, were identical with living species; on the contrary, the Mammalia appear to have been restricted to certain geological horizons; thus the *Lophiodon* is found only in the Middle Eocene, the *Palæotherium* only in the Upper Eocene, the *Rhinoceros* does not appear below the Miocene; so that we are fully entitled to say "the age of *Lophiodon*," "the age of *Palæotherium*," and "the age of *Rhinoceros*."

But on the other hand a minute examination of the older species of the Tertiary Mollusca has shown characters which distinguish them in general from living species.

MM. Deshayes, Fischer, and other conchologists, who have studied the relations of the Tertiary species, think that the absolute identity is not very common among the Mollusca of different ages; on the other hand, the researches of MM. Tournouër, Thomas, etc., have shown that the *Palæotherium* has been contemporary with the

Lophiodon and the *Rhinoceros;* thus the Mollusca have had a less longevity than we at first thought, and the Mammalia have had a greater longevity than we had supposed.

Nevertheless, M. Gaudry is unwilling to admit that variability of the types of the Mollusca has been equal to that of the Mammalia. MM. Darwin and Lyell have long since made this remark, and M. Gaudry has had occasion to confirm the greater longevity[1] of the lower as compared with the higher forms of animals, from his researches in Greece and Mont Léberon, and he shows that the Mollusca have a longer duration in time than the Mammalia, and that the beds at Cabrières, containing among others 15 species of living marine shells, are inferior (stratigraphically) to the bone deposit of Léberon, where the Mammalian remains either present some differences to existing species, or belong to entirely extinct genera, as the *Machairodus, Ictitherium, Dinotherium, Acerotherium, Hipparion, Helladotherium* and *Tragocerus.*

III.—From the study of the different Mammalia, and their distribution at Eppelsheim, Léberon, and Pikermi, M. Gaudry considers that the Upper Miocene may be divided into two zones, and that the deposit at Eppelsheim is not of the same age as the last two; but the solution of this question is not without difficulty. At first some reasons favour the idea that the Eppelsheim deposit is more recent than those of Pikermi and Léberon; for the wild boars of Eppelsheim differ less from the living species; the *Mastodon Pentelici* of Greece seems to be intermediate between the *M. angustidens* of Sansan and the *M. longirostris* of Eppelsheim; the *Leptodon* of Pikermi, of the *Palæotherium* type, is not found at Eppelsheim; the Tapir of Eppelsheim, which has not occurred at Léberon or the three other localities of the same age, has a greater resemblance to the Pliocene species of France; the large tortoise, appearing to indicate a very warm epoch, has not been observed at Eppelsheim. Nevertheless on the whole the proofs are more numerous which infer the deposit at Eppelsheim to be the more ancient. Thus, there are traces of the great Ape at Eppelsheim as at Sansan; the ape of Pikermi does not resemble that of Sansan, but that of the Pliocene marls of Montpelier and the living apes. The Hyænas are found at Léberon, Concud, Baltavar, and Pikermi, but not at Eppelsheim; it is a recent type unknown in the Middle Miocene. The *Simocyon* of Eppelsheim has persistent premolars, in that of Pikermi they are in part deciduous.

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[1] If, by longevity of forms, is understood, not the life of the individual, but the lifetime of the race, it seems hardly possible in some instances to comprehend the vast periods of time which a marine species may have existed, especially among the Mollusca. *Lingulæ*, differing but little from the living species, occur in the Cambrian rocks of Wales. *Terebratula fimbria*, of the Inferior Oolite, might (*externally*) pass for the living *Waldheimia Australis*. The King-crabs (*Limuli*) of the Solenhofen stone can hardly be said to differ from those of the China seas of to-day! Prof. Owen long since pointed out that the chance of survival among land animals was in inverse proportion to their bulk; the largest being always the first to suffer by droughts and all the other causes which affect terrestrial existence, but which are unfelt by and unknown to the fauna of the sea.—Edit. Geol. Mag.

he absence of Giraffes and Antelopes, the presence of *Dorcatherium* ear to *Amphitragulus* of the Lower Miocene gives to Eppelsheim an cient aspect. The *Dicrocerus anocerus* of the same bed has the orns simply forked as those of the young *Cervus elaphus*, which ows an evolution less advanced than the *C. Matheronis* of Léberon which the horns have three tines; besides, it approaches much ore the *Dicrocerus Aurelianensis* of the Middle Miocene.

From this it appears the Upper Miocene of Europe may be divided to two stages; one, more recent, represented by Pikermi, Léberon, altavar, and Concud; the other, more ancient, represented by ppelsheim.

The Upper Miocene is not the only stage where we find appreciable differences in the fauna. As geology progresses, the better we recognize that the organic world has undergone many changes. he following table shows the succession of the terrestrial faunas of e Tertiary Mammalia:—

LIOCENE.—

a. Fauna of Cromer, Saint Prest, and Saint Martial.—It is distinguished from the preceding fauna by the disappearance of Mastodon; the *Elephas meridionalis* has the molars with more serrated laminæ and a more compact enamel; the stags assume more branched and more expanded horns.

b. Fauna of Perier and of the Norwich Crag.—Distinguished from the preceding by the abundance of stags, the rarity or absence of antelopes, the disappearance of Apes. Co-existence of *E. meridionalis* with the *Mastodon.*

c. Fauna of Montpelier.—Distinguished by the absence of *Helladotherium*, *Dinotherium*, *Ictitherium*, and *Ancylotherium*; the presence of the Tapir and *Hyænarctos.* Co-existence of stags with antelopes.

PPER MIOCENE—

d. Fauna of Mont Léberon and Pikermi.—Distinguished by the profusion of antelopes, the presence of *Helladotherium*, *Ictitherium*, and *Hyæna*, the absence of *Dorcatherium* and Tapir.

e. Fauna of Eppelsheim.—Distinguished by the substitution of *Hipparion* for *Anchitherium*, *Mastodon longirostris* for *M. angustidens*, and also by the presence of the great wild boars together with the *Dorcatherium*, *Simocyon*, and Tapir.

IDDLE MIOCENE—

f. Fauna of Simorre.—It differs slightly from the preceding by the presence of *Dinotherium giganteum*, *Histriodon*, *Rhinoceros brachypus*, and *Simorrensis*: and the absence of *Chalicotherium* and antelopes.

g. Fauna of Sansan.—Notwithstanding its close relation, it is separated from the preceding fauna by the absence of *Anthracotherium*, *Cainotherium*, *Dremotherium*, and by the abundance of antelopes.

h. Fauna of the sands of Orleannais.—Distinguished from the preceding by the absence of *Hyænodon*, and the presence of many species common to Sansan and even of Simorre, associated with *Anthracotherium onoideum*, *Palæochærus*, *Cainotherium*, *Dremotherium*, *Dicrocerus Aurelianensis.* Reign of *Dinotherium Cuvieri*, *Mastodon angustidens*, and *M. turicensis.*

OWER MIOCENE—

i. Fauna of a part of the Allier étage (age of the Limestone of Beauce).—Distinguished by the disappearance of *Palæotherium*, the incoming of *Anchitherium*, and the replacement of the *Gelocus* by the *Dremotherium.*

k. Fauna of Ronzon and Villebramar (age of the Sands of Fontainebleau).—Differs slightly from the preceding fauna by the rarity of the *Palæotherium*, absence of *Anoplotherium*, the abundance of *Bothryodon*, and of ruminants named *Gelocus.* Continuation of the reign of *Entelodon.*

UPPER EOCENE—

l. Fauna of the phosphorites of Caylux (age of the Limestone of Brie).—Distinguished from the preceding by the increase of the *Entelodon*, the great *Anthracotherium*, the *Cainotherium*, contemporary with the *Anoplotherium* and *Palæotherium*.

m. Fauna of the gypsum of Paris, of Bembridge, and of the lignites of Debruge.—Distinguished from the preceding by the absence or rarity of *Lophiodon*. Reign of *Palæotherium*, *Anoplotherium*, *Chæropotamus*, *Dichobune*, *Xiphodon*, *Hyænodon*, and *Pterodon*.

MIDDLE EOCENE—

n. Fauna of Hordwell and Mauremont (age of Sands of Beauchamp).—*Dichodon*, *Microchærus*, *Rhagatherium*. The appearance of the *Palæotherium* with the *Lophiodon*.

o. Fauna of Egerkingen, Argenton, Issel, and Calcaire Grossier of Paris. Reign of *Lophiodon* and *Pachynolophus*.

LOWER EOCENE—

p. Fauna of London Clay.—*Hyracotherium*, *Pliolophus*.

q. Fauna of the Plastic Clay of Soissonnais.—*Coryphodon*, *Palæonictis*.

r. Fauna of the grits of La Fère.—*Arctocyon*.

IV.—From the preceding summary it will be seen that the fauna of Eppelsheim must have had a different facies from those of Léberon and Pikermi, because it contained neither Hyæna, *Helladotherium*, Giraffe, nor those great herds of Antelopes which gave an African aspect to the faunas of Léberon and Pikermi. But with these contrasts we find identical species in the deposits of Germany, Greece, and Provence; all the faunas of the Upper Miocene of Europe represent degrees of evolution so related, that at first it is difficult to say which has been the more ancient. M. Gaudry considers that the difference of age between the two sub-divisions of the Upper Miocene is but trifling, and that the different faunas may be attributed in part to the changes in the physical features of the surface which altered the habitats of the animals, and occasioned the displacement of the faunas. For in supposing that the organic world has gradually progressed, if geologists find sudden appearances of fossils in passing from one stage to another, it is because they have in general placed the limits on points where there have been displacements of faunas. The palæontologist, who does not believe in migrations and local extinctions, seeks in vain to connect the chain of ancient beings; he finds appearances, disappearances, and recurrences without being able to explain them.

V.—From the reasons given in the preceding paragraph it would be useless to seek in the same country for an uninterrupted chain of fossil beings; to find such a chain we must uncover all the strata of the earth. But if in passing from one stage to another we perceive breaks, we find also analogous forms. Thus, in comparing the Mammalia of the Upper with the Lower Miocene, we find—*Simocyon* analogous to *Amphicyon*, *Ictitherium Orbignyi* to *Viverra*, *Machairodus cultridens* to *M. palmidens*, *Ancylotherium* to *Macrotherium*, *Mastodon longirostris* and *Pentelici* to *M. angustidens*, *Rhinoceros Schleiermacheri* to *R. Sansaniensis*, *Sus palæochærus* to *S. chæroides*, *Chalicotherium* to *Anisodon*, *Dicrocerus anocerus* to *D. Aurelianensis*, *Gazella deperdita* and *brevicornis* to *G. Martiniana*. Many Pliocene species of Europe ought in their turn to be considered analogous to the animals of the Upper Miocene. These are—*Semnopithecus monspessulanus* is analogous to *Mesopithecus*, *Hyæna Perrieri* and *brevirostris* to *H. eximia*, *Sus provincialis* to *S. antiquus*, *Mastodon arvernensis* to *M. longirostris* and *Pentelici*, *Tapirus arvernensis* and *major* to *T. priscus*, *Antilope Cordieri* to *Tragocerus amaltheus*, *Dicrocerus australis* to *D. aninocerus*. These analogies reveal a certain resemblance between the fauna of the Upper Miocene and those which have preceded and followed it. Although this resemblance shows itself more in the general aspect than in the detail, it ought to be fully considered by those who wish to understand the plan of creation. Indeed, in admitting that which is called the law of creation, we must suppose either that in creating the beings of one geological epoch, the Creator has partly taken for models those of preceding epochs, or believe that the analogies represent a connexion with some near or remote parentage. M. Gaudry prefers the latter hypothesis, because the majority of species have a greater number of resemblances, than of differences, so that it would appear more simple to derive one from the other, than to destroy them in order to replace them, and thus species have not a distinct origin, but are of the same type which has undergone slight modifications.

VI.—"For more than twenty years," writes M. Gaudry, "the history of the modern period appeared to indicate the absence of natural races.

"The Mummies of Egypt have not offered any differences which the animals now living do not maintain, and we can only conclude that the species were unchanged.

"But now it is acknowledged that the actual epoch reaches back much further than the age of the Egyptian mummies; so that, as remarked by the illustrious Pictet (whose loss we all deplore), the existing Fauna is only a part of the Quaternary Fauna; for that period comprehends nearly all the modern species of Mammalia, and we can perhaps only distinguish a few of the larger quadrupeds which were displaced before historic times.

"But it is very probable that many of the animals named as characteristic of the Quaternary epoch are of the same species as those now existing, and represent only particular varieties or races: for example, the spotted Hyæna, the Lion, the European Bison, the existing *Bovidæ*, the *Cervus elaphus*, seem to be only modified varieties of the *Hyæna spelæa*, the *Felis spelæa*, the *Bison priscus*, the *Bos primigenius* and the *Cervus Canadensis* of the Quaternary deposits.

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"I could greatly multiply examples; these, however, are doubtless sufficient to explain within what limits animals issuing from the same parents appear to me to merit the name of species or represent only the race.

"Whatever be the difficulties of indicating the separation between extinct species and races, I think that this task is worthy to attract the attention of Naturalists." J. M.

REVIEWS.

DES TERRAINS STRATIFIÉS, CONSIDÉRÉS AU POINT DE VUE DE L'ORIGINE DES SUBSTANCES QUI LES CONSTITUENT ET DU TRIBUT QUE LEUR ONT APPORTÉ LES PARTIES INTERNES DU GLOBE. By M. DAUBRÉE. (From the Bull. of the Geol. Soc. of France, 2nd Series, vol. xxviii. p. 363. Paris, 1871. pp. 58.)

THIS "note" as it is called is in truth an elaborate essay on that most intricate of subjects—the chemical origin of rocks. It abounds in references to previous works on the subject, although some writers who are identified with it, such as Dr. Sterry Hunt for instance, are curiously enough absent from the list of those quoted.

In studying the origin of the composition of the sedimentary rocks as we know them now, M. Daubrée is not content with tracing their constituent parts to the more recent reservoirs of sea and land, whence they were undoubtedly in the last instance derived, but, like an enthusiastic pedigree-maker, he must fain go back to the dark ages, and the interior of the earth is the great laboratory to which he pushes back all or almost all our familiar rock-making substances. Of course much of what M. Daubrée advances is pure hypothesis, and the "scientific Uses of the Imagination" are nowhere better shown than in disquisitions dealing with such obscure and unknown regions as the "Bowels of the Earth." The paper is, however, full of suggestive thoughts, and is useful as giving in a clear and definite manner the opinions of a chemist and geologist so well known as is its writer.

M. Daubrée unites with M. Delesse in attaching considerable importance to the *submarine* volcanic deposits of which, beyond the fact of their existence, we really know very little. To them, including of course thermal waters charged with all kinds of extraneous substances, the presence of most of the rock-forming bodies not directly attributable to trituration is referred by them. To the sea with its many constituents M. Daubrée does not allow much influence in the formation of great deposits unless it be aided by subterranean heat. With regard to rock-salt, for instance, he says, that although the theory that it could be produced similarly to the salt which is found in the neighbourhood of volcanoes is untenable,[1] yet the mere evaporation of salt water at the ordinary temperature cannot satisfactorily explain its existence, since it would not account for the preservation of deliquescent salts, such as carnallite. "How," he adds, "without mentioning Borate of Magnesia or Stassfurtite, could Hematite, limpid quartz with very distinct forms, Anhydrite in complete crystals, such as are scarcely known elsewhere, and Boracite such as has quite recently been found there, have crystallized in the midst of these deposits?" These facts amongst others convince our author that the evaporation to which deposits of rock-salt "apparently" owe their origin was caused, not by the action of the atmosphere alone, but was aided by hot emanations from the interior of the earth. M. Daubrée argues in the same way respecting such beds of dolomite to the formation of which the sea may have contributed. These few remarks will suffice to give some notion of the kind of questions which M. Daubrée treats of in the paper under consideration, which is one of the most extensive generalizations on great geological problems which have appeared for some years. G. A. L.

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[1] This theory was held by Breislack, de Charpentier, Paul Savi, and others.

REPORTS AND PROCEEDINGS.

ADDRESS TO THE GEOLOGICAL SECTION AT THE OPENING OF THE FORTY-THIRD MEETING OF THE BRITISH ASSOCIATION AT BRADFORD, September 18th, 1873. By JOHN PHILLIPS, M.A., D.C.L., Oxon., LL.D. Cambridge and Dublin, F.R.S., F.G.S., President of the Section.

More than half the life of an octogenarian separates us from the birthday of the British Association in Yorkshire; and few of those who then helped to inaugurate a new scientific power can be here to-day to estimate the work which it accomplished, and judge of the plans which it proposes to follow in future. Would that we might still have with us the wise leading of Harcourt, and the intrepid advocacy of Sedgwick—names dear to Geology, and always to be honoured in Yorkshire!

The natural sciences in general, and Geology in particular, have derived from the British Association some at least of the advantages so boldly claimed at its origin: some impediments have been removed from their path; society looks with approbation on their efforts; their progress is hailed among national triumphs, though achieved for the most part by voluntary labour; and the results of their discoveries are written in the prosperous annals of our native industry.

In most cases scientific truth is established before that practical application is possible which constitutes a commercial revolution and is welcomed with applause by the community. What a change has happened within forty, nay, twenty years, in the ironworks of this country! But long before the foundations of furnaces were laid at Middlesborough, the ferruginous bands in the Yorkshire cliffs had been often explored by geologists, and waited only for the railway to yield millions of tons of ore. The occurrence of good ironstone in the Liassic strata of England is a source of profit as far to the south as Oxfordshire; Northamptonshire yields it in abundance at the base of the Oolites, and Lincolnshire above them, while on the Yorkshire coast, in addition, we have smaller beds in the midst of the Oolites, through nearly the whole range associated with poor and thin coal.

To determine the extent of the British Coal-fields, and the probable duration of the treasures which they yield, and to discover, if possible, other fields quite undreamed of by practical colliers, are problems which geology has been invited to solve; and much progress has been made in these important inquiries by private research and the aid of a public commission. The question most interesting to the community—the extent to which known Coal-fields reach beneath superior strata, and the situation of other fields having no outcrop to the surface—can often be answered on purely geological grounds, within not very wide limits of probability.

If, for example, we ask how far to the eastward the known Coal-strata may extend under the Vale of York, a reasonable answer is furnished by Mr. Hull and the Government Commission. The whole great coal deposit extending from Bradford to Nottingham, passes under the Magnesian Limestone, and may be found for at least a few miles in breadth within attainable depths. It passes under a part of the Vale of York, probably south of the city. But before attempting to give a practical value to this opinion, it may be well to remember that, fully tried, the experiment would be too costly for individual enterprise, while if successful it would benefit more than a county—and that not only a large outlay must be provided for it, but arrangements made for persevering through several years in the face of many difficulties, and perhaps eventual disappointment. Still, sooner or later, the trial must be made; and geology must direct the operation.

Considerations of this kind invest with more than momentary interest the great undertaking to which Mr. Godwin-Austen called attention in his address to the

Geological Section at Brighton. Not to dig gypsum, not to open a new supply of salt, not to discover coal in Sussex, but to find out what is below the Wealden and thus contribute to solve a great practical problem for London and all the south of England, have geologists undertaken the deep boring near Hastings. What is below the Wealden? Do the Oolitic rocks continue beneath it with their usual characters and thickness? or do they suffer that remarkable diminution which is observed in their eastward declination through the Midland Counties? Do they occur at all there? may they lie only in separate patches amidst older rocks? may these older rocks, continued from Belgium, appear at once or at no great depth below the Wealden, and bring with them, if not coal, some sure knowledge of the way in which the great subterranean anticlinal passes from the Rhineland through Belgium to Somerset, South Wales, and Ireland? Such an experiment must not be allowed to come to a premature end.

Turning, however, from these topics, which involve industrial interests, to other lines of geological research, we remark how firmly since 1831 the great facts of rock-stratification, succession of life, earth-movement, and changes of oceanic areas have been established and reduced to laws—laws, indeed, of phenomena at present, but gradually acquiring the character of laws of causation.

Among the important discoveries by which our knowledge of the earth's structure and history has been greatly enlarged within forty years, place must be given to the results of the labours of Sedgwick and Murchison, who established the Cambro-Silurian systems, and thus penetrated into ancient time-relics very far toward the shadowy limit of palæontological research. Stimulated by this success, the early strata of the globe have been explored with unremitting industry in every corner of the earth; and thus the classification and the nomenclature which were suggested in Wales and Cumberland are found to be applicable in Russia and India, America and Australia, so as to serve as a basis for the general scale of geological time, founded on organic remains of the successive ages.

This great principle, the gift of William Smith, is also employed with success in a fuller study of the deposits which stand among the latest in our history, and involve a vast variety of phenomena, touching a long succession of life on the land, changes of depth in the sea, and alterations of climate. Among these evidences of physical revolution, which, if modern as geological events, are very ancient if estimated in centuries, the earliest monuments of man find place—not buildings, not inhabited caves or dwellings in dry earth-pits, not pottery or fabricated metal, but mere stones shaped in rude fashion to constitute apparently the one tool and one weapon with which, according to Prestwich, and Evans, and Lubbock, the poor inhabitant of northern climes had to sustain and defend his life.

Nothing in my day has had such a decided influence on the public mind in favour of geological research, nothing has so clearly brought out the purpose and scope of our science, as these two great lines of inquiry, one directed to the beginning, the other to the end of the accessible scale of earthly time; for thus has it been made clear that our purpose can be nothing less than to discover the history of the land, sea, and air, and the long sequence of life, and to marshal the results in a settled chronology—not, indeed, a scale of years to be measured by the rotations or revolutions of planets, but a series of ages slowly succeeding one another through an immensity of time.

There is no question of the truth of this history. The facts observed are found in variable combinations from time to time, and the interpretations of these facts are modified in different directions; but the facts are all natural phenomena, and the interpretations are all derived from real laws of those phenomena,—some certified by mathematical and mechanical research, others based on chemical discovery, others due to the scalpel of the anatomist, or the microscopic scrutiny of the botanist. The grandest of early geological phenomena have their representatives, however feeble, in the changes which are now happening around us; the forms of ancient life most surprising by their magnitude or singular adaptations can be explained by analogous though often rare and abnormal productions of to-day. Biology is the contemporary index of Palæontology, just as the events of the nineteenth century furnish explanations of the course of human history in the older times.

To forget, in referring to this subject, the name of our great and veteran leader, Sir Charles Lyell, would be difficult for any who have profited by the perusal of his masterly works, is impossible for those who, like me, have been witnesses of ıat life-long zeal and energy which carried him to explore distant regions and ıake friends for English Geology in every quarter of the globe.

Keeping our attention on Pleistocene Geology, we may remark that the famous ıvern of Kirkdale, with the equally celebrated rock-den of bears and hyænas at 'orquay, receives no small help toward clearing up the history of mammalia in ritain from the explorations now going on in the limestone cliffs not far from this lace of meeting. In Kirkdale Cave no trace of human art appeared; Kent's Hole as given proofs of the presence of man from the earliest period characterized by ıe remains of the great bear; and both there and in the Victoria Cave near ettle, at much later periods, domestic occupation is fully established.

It will be readily conceded that for gathering good information regarding the borigines of our land the British Association has wisely appropriated some por- on of its funds; probably we shall agree in thinking that the additional data 'hich may be expected are worthy of further expenditure and the employment of aluable labour. And this leads me to remark how real is the obligation of this ssociation to some of its members who have directed these researches, and how ırge a debt of gratitude is due to one in particular, who, not content with turning very day his intelligent eyes on the remarkable phenomena disclosed by excava- on in the Torquay caverns, has with his own hands cleared and washed thousands f bones and teeth, studied, labelled, and arranged them, and year by year has de- ghted this Section with careful narratives of what he and Mr. Vivian, following ıe steps of MacEnery, have surely observed and recorded. Labour of this kind ıe Association cannot purchase; nor would the generous spirit of my friend con- :nt to such a treaty. I may, however, use the privilege of my temporary office, nd suggest to you to consider whether the time is not come for the friends of the ssociation, and especially the members of this Section, to unite in a general fort, and present to Mr. Pengelly a substantial proof that they highly appreciate is disinterested labours in their service, and the ample store of new knowledge 'hich he has had so large a share in producing.

During the long course of geological time the climates of the earth have changed. ı many regions evidence of such change is furnished by the forms of contemporary fe. Warm climates have had their influence on the land, and favoured the rowth of abundant vegetations as far north as within the arctic circle; the sea has ourished reef-making corals in northern Europe during Palæozoic and Mesozoic zes; crocodiles and turtles were swimming round the coasts of Britain, among lands clothed with Zamiæ and haunted by marsupial quadrupeds. How have we st this primæval warmth? Does the earth contribute less heat from its interior ores? does the atmosphere obstruct more of the solar rays or permit more free diation from the land and sea? has the sun lost through immensity of time a :nsible portion of his beneficent influence? or, finally, is it only a question of the evation of mountains, the course of oceanic currents, and the distribution of land ıd sea?

The problems thus suggested are not of easy solution, though in each branch of ıe subject some real progress is made. The globe is slowly changing its dimen- ons by cooling; thus inequalities and movements of magnitude have arisen and 'e still in progress on its surface: the effect of internal pressure, when not resulting mass-movement, is expressed in the molecular action of heat which Mallet plies to the theory of volcanoes. The sun has no recuperative auxiliary known Thomson for replacing his decaying radiation; the earth, under his influence, as as shown by Herschel and Adhemar, is subject to periods of greater and less armth, alternately in the two hemispheres and generally over the whole surface; ıd finally, as Hopkins has shown, by change of local physical conditions the imate of northern zones might be greatly cooled in some regions and greatly armed in others.

One is almost frozen to silence in presence of the vast sheets of ice which some my friends (followers of Agassiz) believe themselves to have traced over the ountains and vales of a great part of the United Kingdom, as well as over the ndred regions of Scandinavia. One shudders at the thought of the innumerable ebergs with their loads of rock, which floated in the once deeper North Sea, and ›ove the hills of the three Ridings of Yorkshire, and lifted countless blocks of ilurian stone from lower levels, to rest on the precipitous limestones round the ›urces of the Ribble.

Those who, with Professor Ramsay, adopt the glacial hypothesis in its full extent, and are familiar with the descent of ice in Alpine valleys where it grinds and polishes the hardest rocks and winds like a slow river round projecting cliffs, are easily conducted to the further thought that such valleys have been excavated by such ice-rubbers, and that even great lakes on the course of the rivers have been dug out by ancient glaciers which once extended far beyond their actual limits. That they did so extend is in several instances well ascertained and proved: that they did in the manner suggested plough out the valleys and lakes is a proposition which cannot be accepted until we possess more knowledge than has yet been attained regarding the resistance offered by ice to a crushing force, its tensile strength, the measure of its resistance to shearing, and other data required for a just estimate of the problem. At present it would appear that under a column of its own substance 1000 ft. high, ice would not retain its solidity; if so, it could not propagate a greater pressure in any direction. This question of the excavating effect of glaciers is distinctly a mechanical problem, requiring a knowledge of certain data; and till these are supplied, calculations and conjectures are equally vain.

A distinguishing feature of modern geology is the great development of the doctrine that the earth contains in its burial-vaults, in chronological order, forms of life characteristic of the several successive periods when stratified rocks were deposited in the sea. This idea has been so thoroughly worked upon in all countries, that we are warranted to believe in something like one universal order of appearance in time, not only of large groups but even of many genera and species. The Trilobitic ages, the Ammonitic, Megalosaurian, and Palæotherian periods are familiar to every geologist. What closed the career of the several races of plants and animals on the land and in the sea, is a question easily answered for particular parts of the earth's surface by reference to "physical change"; for this is a main cause of the presence or absence, and in general of the unequal distribution of life. But what brought the succession of different races in something like a constant order, not in one tract only, but one may say generally in oceanic areas, over a large portion of the globe?

Life unfolds itself in every living thing, from an obscure, often undistinguishable cell germ, in which resides a potential of both physical and organic change—a change which, whether continual or interrupted, gradual or critical, culminates in the production of similar germs, capable under favourable conditions of assuming the energy of life.

How true to their prototypes are all the forms with which we are familiar, how correctly they follow the family pattern for centuries, and even thousands of years, is known to all students of ancient art and explorers of ancient catacombs. But much more than this is known. Very small differences separate the elephant of India from the mammoth of Yorkshire, the *Waldheimia* of the Australian shore from the *Terebratula* of the Cotswold Oolite, the dragon-fly of our rivers from the *Libellula* of the Lias, and even the *Rhynchonellæ* and *Lingulæ* of the modern sea from the old species which swarm in the Palæozoic rocks.

But concurrently with this apparent perpetuity of similar forms and ways of life, another general idea comes into notice. No two plants are more than alike; no two men have more than the family resemblance; the offspring is not in all respects an exact copy of the parent. A general reference to some earlier type, accompanied by special diversity in every case ("descent with modification"), is recognized in the case of every living being.

Similitude, not identity, is the effect of natural agencies in the continuation of life-forms, the small differences from identity being due to limited physical conditions, in harmony with the general law that organic structures are adapted to the exigencies of being. Moreover the structures are adaptable to new conditions: if the conditions change, the structures change also, but not suddenly; the plant or animal may survive in presence of slowly altered circumstances, but must perish under critical inversions. These adaptations, so necessary to the preservation of a race, are they restricted within narrow limits? or is it possible that in the course of long-enduring time, step by step and grain by grain, one form of life can be changed and has been changed to another, and adapted to fulfil quite different functions? Is it thus that the innumerable forms of plants and animals have been "developed" in the course of ages upon ages from a few original types?

This question of development might be safely left to the prudent researches of Physiology and Anatomy, were it not the case that Palæontology furnishes a vast range of evidence on the real succession in time of organic structures, which on the whole indicate more and more variety and adaptation, and in certain aspects a growing advance in the energies of life. Thus at first only invertebrate animals appear in the catalogues of the inhabitants of the sea, then fishes are added, and reptiles and the higher vertebrata succeed; man comes at last, to contemplate and in some degree to govern the whole.

The various hypothetical threads by which many good naturalists hoped to unite the countless facts of biological change into an harmonious system have culminated in Darwinism, which takes for its basis the facts already stated, and proposes to explain the analogies of organic structures by reference to a common origin, and their differences to small, mostly congenital, modifications which are integrated in particular directions by external physical conditions, involving a "struggle for existence." Geology is interested in the question of development, and in the particular exposition of it by the great naturalist whose name it bears, because it alone possesses the history of the development *in time*, and it is to inconceivably long periods of time, and to the accumulated effect of small but almost infinitely numerous changes in certain directions, that the full effect of the transformations is attributed.

For us, therefore, at present it is to collect with fidelity the evidence which our researches must certainly yield, to trace the relation of forms to time generally and physical conditions locally, to determine the life-periods of species, genera, and families in different regions, to consider the cases of temporary interruption and occasional recurrence of races, and how far by uniting the results obtained in different regions the alleged "imperfection of the geological record" can be remedied.

The share which the British Association has taken in this great work of actually reconstructing the broken forms of ancient life, of repeopling the old land and older sea, of mentally reviving, one may almost say, the long-forgotten past, is considerable, and might with advantage be increased. We ask, and wisely, from time to time, for the combined labour of naturalists and geologists in the preparation of reports on particular classes or families of fossil plants and animals, their true structure and affinities, and their distribution in geological time and geographical space. Some examples of this useful work will, I hope, be presented to this Meeting. Thus have we obtained the aid of Agassiz and Owen, and have welcomed the labours of Forbes, and Morris and Lycett, and Huxley, of Dawkins and Egerton, of Davidson, Duncan, and Wright, of Williamson and Carruthers and Woodward, and many other eminent persons, whose valuable results have for the most part appeared in other volumes than our own.

Among these volumes let me in a special manner recall to your attention the priceless gift to Geology which is annually offered by the Palæontographical Society, a gift which might become even richer than it is, if the literary and scientific part of our community were fortunate enough to know what a perpetual treasure they might possess in return for a small annual tribute. The excellent example set and the good work recorded in the Memoirs of the Society referred to have not been without influence on foreign men of science. We shall soon have such Memoirs from France and Italy, Switzerland and Germany, America and Australia; and I trust the effect of such generous rivalry will be to maintain and increase the spirit of learned research and of original observation which it is our privilege and our duty to foster, to stimulate, and to combine.

On all the matters, indeed, which have now been brought to your thoughts the one duty of geologists is to collect more and more accurate information; the one fault to be avoided is the supposition that our work is in any department complete. We should speak modestly of what has been done; for we have completed nothing, except the extinction of a crowd of errors, and the discovery of right methods of proceeding toward the acquisition of truth. We may speak hopefully of what is to be accomplished; for the right road is before us. We have taken some steps along it; others will go beyond us and stand on higher levels. But it will be long before any one can reach the height from which he may be able to survey the whole field of research and collect the results of ages of labour.

. . . primaque ab origine mundi
Ad sua perpetuum deducere tempora carmen.

CORRESPONDENCE.

THE EARLIEST DISCOVERED EVIDENCE OF EXTINCT STRUTHIOUS BIRDS IN NEW ZEALAND.

SIR,—I have the pleasure, agreeably with your request, to inform you that I have received the permission of Benjamin Bright, Esq., to deposit in the British Museum the portion of "bone of an unknown Struthious bird of large size, presumed to be extinct,"—described and figured in the third volume of the "Transactions of the Zoological Society," p. 29, pl. iii., and subsequently determined as the shaft of the femur of *Dinornis Struthioïdes* (Owen).

The individual who, in October, 1839,[1] brought this specimen to me, for sale, at the Royal College of Surgeons, asked ten guineas for it. When I had convinced myself that it was the shaft of the femur of a Bird, and that the evidence supplied by the vendor made it at least probable that the specimen had been found in New Zealand, I reported the circumstances to the Board of Curators of the Royal College of Surgeons, and recommended the purchase of the specimen. This was declined. I had determined, on being entrusted with office in the Hunterian Museum, not to form a private collection, and my circumstances, in 1839, did not allow me to give ten guineas for a specimen; and this I stated to the vendor, in requesting permission to describe and figure it: which permission he liberally granted.

The specimen was purchased by Benjamin Bright, Esq., of Bristol, to whom a copy of the abstract of my paper had been sent, and was placed in his private museum; which, on his decease, came into the possession of his son. On communicating to this gentleman the desirability of the original bone of the *Dinornis* being deposited in the British Museum, he most liberally permitted me to submit to the Trustees an offer, as a donation, of the entire Collection made by his father and grandfather, including the original specimen which initiated the series of papers on the *Dinornis* that have since appeared in the "Zoological Transactions."

RICHARD OWEN.

ON THE RELATION OF PTERASPIS AND SCAPHASPIS.

SIR,—I have but just seen Magister Schmidt's letter in the July Number of the GEOLOGICAL MAGAZINE (p. 330). *Ex cathedrâ* utterances are interesting only when the individual who indulges in them is for some reason the representative of a party, or has acquired the confidence of qualified critics. For Mr. Schmidt therefore to tell us that Kunth's evidence appears "most satisfactory," and that the two shields figured by him "are not brought into contact accidentally," is sheer waste of your space and of his time. If he will have the goodness to send to you some reasoning upon the existing *data*, or an account of new *data* bearing on the matter, he will possibly render some service to English geologists; but off-hand enunciations of simple opinion have no special value because they come from Russia.

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[1] See "Proceedings of the Zoological Society," November 12, 1839, p. 169.

Mr. Schmidt obviously can tell us no more about Kunth's specimen than what we have seen, and what he has seen, in Kunth's paper.[1]

It is interesting to read that Mr. Schmidt thinks he has found bone-lacunæ in *Pteraspis*; but it is desirable to caution the readers of the Geol. Mag. as to accepting the supposed fact. There have been so many blunders on the Continent with regard to *Pteraspis*, that it will not be wise to attach any importance to the statement until we have evidence that the shield examined was really that of *Pteraspis*. It is not at all improbable that it was, but it is also not improbable that it was something else.

E. Ray Lankester.

Exeter College, Oxford,
Sept. 1st, 1873.

MR. WARD ON THE GLACIATION OF THE LAKE DISTRICT.

Sir,—On reading Mr. J. Clifton Ward's paper on the above subject, in the last number of the Quarterly Journ. of the Geol. Society, I find that he has been led by an independent series of observations to corroborate several statements and opinions I have from time to time advanced in the pages of the Geological Magazine. But as Mr. Ward does not refer to what others have done before him in the Lake District, would you allow me to direct the attention of those of your readers who are interested in the subject to Vol. VII., August, October, and December, 1870; Vol. VIII., February, June, and July, 1871; and Vol. IX., September, 1872. In one or other of these seven articles several phenomena noticed by Mr. Ward have been described; the results of observations on the dispersion of syenite erratics from the Buttermere and Ennerdale centres, stated; the distinction between mounds of Boulder-clay, sand, gravel, and glacial moraines, discussed; the almost entire limitation of true moraines to the upper valleys, advocated (contrary to prevailing ideas); the transportation of erratics by floating-ice in various directions, and often irrespectively of the drainage, insisted on, etc. In making these remarks my object is very far from undervaluing the great mass of entirely new information contained in Mr. Ward's paper.

D. Mackintosh.

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[1] Magister Schmidt had forwarded an earlier communication than that referred to above, which appeared in the April Number of the Geol. Mag. (p. 152), in which is also contained a refutation of Dr. Kunth's views by Mr. Lankester (p. 190). Doubtless M. Schmidt has good grounds for the opinions he has expressed concerning the assumed relationship to each other of *Pteraspis* and *Scaphaspis*—as the dorsal and ventral shields of the same individual—and we shall be glad to receive a further account of his researches on this important subject.—Edit. Geol. Mag.

OBITUARY.

Miss Carne.—We regret to record the death of Miss Elizabeth Carne, a native of West Cornwall, on Sept. 7, at Penzance, aged 56. She was the daughter of the late Joseph Carne, Esq., F.R.S., and inherited her father's scientific tastes and literary acquirements as well as his fortune. For years she was one of the most frequent writers in the *London Quarterly Review*, and has published several works which have obtained much popularity, although her dislike of publicity led her to write anonymously. Her works include "Country Towns," "Three Months' Rest at Pau," and "The Realm of Truth." Miss Carne for many years largely devoted her time to the Mineralogical Museum of the Royal Geological Society of Cornwall, at Penzance, every specimen in which she classified and arranged, so that the Museum was regarded as a model of method. She was thoroughly versed in geology and mineralogy, and contributed many papers to the Royal Cornwall Geological Society. Her benevolence was as great as her attainments were rare, and, in addition to large benefactions in more ordinary channels, Miss Carne lately offered to build a new wing to the local mineralogical museum and furnish it with the mineral collection, valued at £3,000, which her father had amassed. This project having fallen through, Miss Carne resolved to build a museum of her own at Penzance, and this is now approaching completion.—*Pall Mall Gazette*, September 9.

Gustav Rose.—This distinguished Mineralogist died at Berlin, July 15th, in the 76th year of his age. In him Germany and the world have lost a wise and noble man,—conceded by all to be the first in science among the learned men of Germany. At first devoting himself to engineering, he subsequently gave all his time to scientific pursuits, and in 1823 took up his residence in Berlin. In 1826 he became Professor of Mineralogy in that University, and, after the death of Weiss, Director of the Royal Mineralogical Museum. He travelled extensively in Scandinavia, England and Scotland, Italy and Sicily, France and Austria. In 1829 he made with Humboldt and Ehrenberg the famous tour to the Ural and Altai Mountains and the Caspian Sea, and beyond to the borders of China, a journey which first made known the mineralogical resources of the extensive Russian Empire. His researches on his native soil were confined to the Silesian Mountains. He devoted himself to the study of meteorites, those wonderful bodies which reach the earth from stellar space. With his keen penetration he discovered the structure of iron meteorites, and the mineral components of the stony ones; and studied the striking differences between rock-making in a cosmic atom, and in the solid crust of the earth.

Prof. Dr. Kaup.—We regret to record the death of Prof. Dr. Kaup, of Darmstadt, a distinguished Zoologist and Palæontologist, whose name is well known in connexion with the discovery of *Dinotherium*. We hope to give a suitable notice of him next month.

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EOLOGICAL MAGAZINE.

No. CXIII.—NOVEMBER, 1873.

ORIGINAL ARTICLES.

ON THE ORIGIN OF THE ESTUARY OF THE FLEET IN DORSETSHIRE.

By the Rev. O. FISHER, F.G.S.

R. MANSEL-PLEYDELL'S Memoir on the Geology of Dorset, contained in the last two Numbers of this Journal (pp. 402 438), refers to a theory of the formation of the Fleet proposed by srs. Bristow and Whitaker in 1869 (GEOL. MAG. Vol. VI. p. 433). t the time of the appearance of that paper I felt that it was very cult to conceive how the small streams which run into the Fleet d have excavated a channel between the Chesil Beach and the , especially when it is considered that their abrading power t cease at the level of the Fleet water. A different explanation he matter then presented itself to me; and since Mr. Mansel-dell has recurred to the subject, I am induced to forward my ons upon it to the MAGAZINE.

here can be no doubt that the formation of a beach, or spit of gle or sand, depends upon the set of the tides, as governed by configuration of the coast and the prevailing winds; the con-ns of depth, and those for the supply of materials, being at the e time favourable. In the present case it is the Isle of Portland ch mainly determines the position and form of the Chesil ch. The land on the opposite side of the Fleet has really nothing o with it, excepting that the sea-bottom shelving from it furnishes "fleetness," or shallowness, necessary for the detention of the bles. If this land were removed, the Beach would still remain re it is, for it simply occupies the position where, on the whole, causes which bring up the pebbles, and the causes which sweep n away, are equally balanced.

land were to be placed to the westward of the Beach, then, under present neighbouring configuration, the destructive agencies ld exceed the conservative, and the land would be washed away, the beach carried forward until it found a place of rest in its al present position. This is analogous to what I believe has rred. I look upon the Fleet as the eastern half of a submerged ey, similar to, though on a larger scale than, that one which now is the Weymouth Backwater; its former western side having encroached upon, and destroyed, by the waves of the West

we could take up Portland, and plant it a mile or so to the east-l of the position it now occupies, I believe that the sea would tly begin to advance eastwards, pushing the beach before it, until soon the Weymouth Backwater would be invaded, and the eastern portion would become a small estuary, enclosed in front by a beach, exactly as the Fleet is now.

Under this theory the denudation problem is reduced to the formation of estuaries in general, such as we find at [illegible], the Lodmore, almost silted up, and screened by its own beach; [illegible] Southampton, and so on. They are all the drowned ends of valleys excavated at a remote period, when the land stood higher than it does at present, and which was probably long antecedent to that during which the submarine forests, which occur on most low shores, were flourishing.

Such a mode of origin for the Fleet would support the view of the great antiquity of the present surface contour, evidenced in this as in other instances, by the extensive tracts of land which must have since disappeared. This is proved by the abrupt manner in which the general form of the surface is cut off by the sea-board, presenting either lofty cliffs, low shores, or estuaries, which depend wholly upon the already existing form of the ground at the line to which the sea has advanced.

II.—On some Specimens of *Dithyrocaris* from the Carboniferous Limestone Series, East Kilbride, and from the Old Red Sandstone of Lanarkshire.

By Henry Woodward, F.R.S., F.G.S., etc.,
of the British Museum, and
Robert Etheridge, Jun., F.G.S., etc.,
of the Geological Survey of Scotland.

PLATE XVI.

THE nine specimens of Phyllopodous Crustacea, about to be noticed, are, with one exception, that from Lanarkshire, all from the [illegible] Carboniferous Limestone series, East Kilbride, a locality already well known to local geologists as having yielded a very rich series of Carboniferous forms.

The specimens from East Kilbride were collected by Mr. A. [illegible] and Mr. J. Bennie; that from the Old Red of Lanarkshire by Mr. A. Macconochie.

They are all referable to the genus *Dithyrocaris*, of Scouler, originally named by him *Argas*[1], and with one exception are new species.

1. *Dithyrocaris tricornis*, Scouler. Plate XVI. Fig. 1.—syn. *Dithyrocaris Scouleri*, M'Coy, Syn. Carb. Foss. Ireland, t. 23, fig. 2.

The specimen to which we refer this species was obtained from shale over the No. [illegible] limestone at [illegible], on North Lickprivick Farm, near East Kilbride, and presents us with half of a carapace,[2] which

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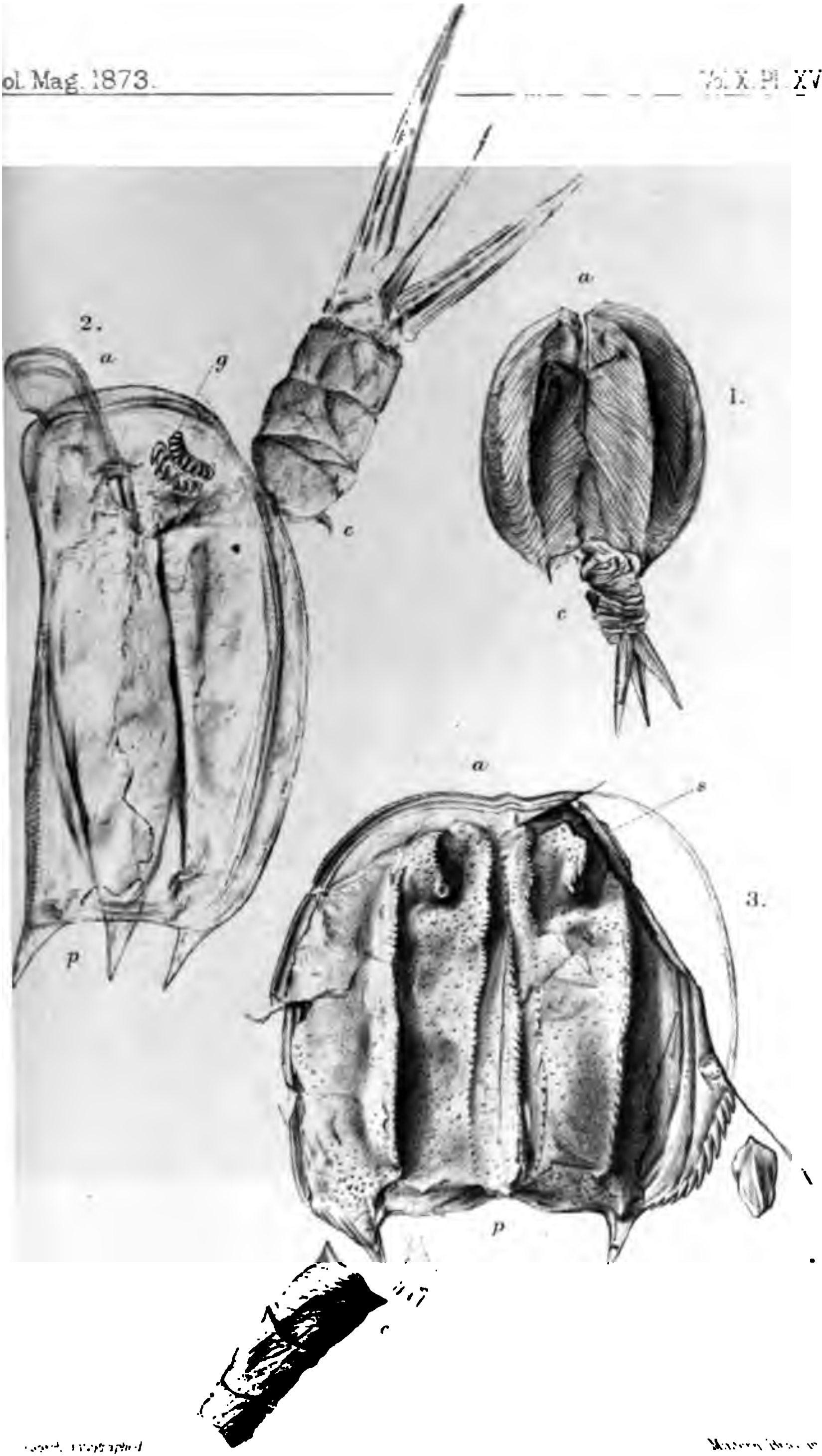
[1] Records of General Science, by Dr. R. D. Thomson, 1836, vol. iv. p. 136.

[2] [illegible] has been found beneath it, as the position [illegible]



[illegible] Lithographed Mintern Bros. imp.

Carboniferous species of Dithyrocaris (Scouler).

in size, is one-third less than Dr. Scouler's original specimen of *D. testudinea* (Figure 1 in our Plate), obtained by him "about a mile to the east of Paisley" (*op. cit.* p. 136). The same raised oblique re-curved and divaricating lines observable in the original specimen of *D. testudinea* mark this smaller example from East Kilbride; a lateral median ridge (seen on *each side* in Dr. Scouler's specimen) marks the centre intermediate between the margin and the dorsal line of the carapace.

The lateral margin of the carapace along its posterior half is relieved by more finely and closely arranged striæ than those which mark the remainder of the shield.

Dimensions of Scouler's original specimen of *D. testudinea* (figured in our Plate XVI. Fig. 1): greatest length of carapace, from latero-posterior spine to frontal border, 35 millimetres; length of dorsal line, 30 mm.; greatest breadth of carapace, 30 mm.; length of caudal segments, including caudal spine, 25 mm.; 3 caudal spines, each 15 mm. long.

Dimensions of Survey specimen of *D. testudinea*: greatest length, 22 mm.; greatest breadth of the *half shield*, 8 mm.

Localities.—Old quarry on North Lickprivick Farm, East Kilbride, in shale above the Main Limestone; Jock's burn, above Hallcraig Bridge, about one mile west of Carluke, in the "Lingula Limestone"; Kirktonholm Cement Works, and the Glebe Quarry, East Kilbride, in shale above the Calderwood Cement Stone. All members of the Lower Carboniferous Limestone Group.—Collected by Messrs. Bennie and Paton.

2. *DITHYROCARIS TRICORNIS*, Scouler (Plate XVI. Fig. 2, Scouler's original specimen; Fig. 3, Survey specimen).

The impression and counterpart of the very beautiful specimen (Plate XVI. Fig. 3) which we have referred to this species was obtained by Mr. J. Bennie from the shale above the Calderwood Cement-stone, Carboniferous Limestone series, East Kilbride.

It is of the utmost importance, as it affords us an entirely new interpretation of Scouler's *D. tricornis* (Plate XVI. Fig. 2), as well as the means of fully describing its characters, which, from the decorticated condition of the original specimen, was hardly possible.

General Portlock, in his grand work, "Geological Report on Londonderry," etc., 1843, acutely observes (p. 313) concerning *Argas* (*Dithyrocaris*) *tricornis*, that "in all probability it depends on an illusive appearance produced by the overlapping of the crusts of different individuals." This, however, is not the true explanation of its anomalous specific character. The three spines truly belong to the carapace, but the so-called "anterior border" of Scouler (Fig. 2 *p*) is really the *posterior* margin, the abdominal segments and tail-spines (*c*) having become displaced during *the decomposition of the softer parts* of the animal, so as to protrude from the anterior extremity of the carapace. This is a common occurrence with the specimens of *Ceratiocaris papilio* from the U. Silurian of Lesmahagow, Lanarkshire (as shown by H. Woodward[1]), and led the late Mr. J. W. Salter to fall into precisely the same error in first describing it.

Upon the accompanying Plate XVI. (Fig. 2), we figure Scouler's original specimen by the side of that just obtained (Fig. 3), a reference to which will best explain the manner in which the carapace has been folded and crumpled together, and the abdominal segments displaced.

The following is extracted from Dr. Scouler's original description of *Dithyrocaris* (*Argas*) *tricornis*:—

"The shell is elliptical but truncated anteriorly,[2] and much more depressed than in the preceding species, and a single ridge runs in the direction of the middle line. At the anterior[2] extremity of the shell there are three acute triangular processes, one at each angle of the shell, the one internal, separating the margin or thin portion from the rest of the shell, and the other line external, dividing the margin into two distinct parts. The posterior[3] extremity of the shell is very indistinct, and the number of joints in the tail could not be ascertained." He adds:—"This specimen, as will be seen by an inspection of the figure, is greatly distorted, the shell has been curved, the tail or abdomen almost separated from the body. The species is, however, completely distinct from the preceding. The three processes at the anterior[2] extremity of the shell, the single ridge running along its middle, are sufficient to distinguish it." (*op. cit.* p. 138.)

The following measurements are taken from Dr. Scouler's specimen (not copied from his description, which gives them rather inaccurately). The carapace measures 3¼ inches=80 mm.; breadth of carapace, 1½ inches=38 mm.; length of caudal segment, 1 inch=25 mm.; breadth, 15 mm.; length of longest tail-spine, 40 mm. From an examination of Dr. Scouler's original specimen by one of us (H. Woodward), the impressions of the maxillæ (see Plate XVI. Fig. 2 *g*) near the anterior extremity of the carapace have clearly been made out.

The projecting portion at the anterior extremity (see Fig. 2 *a*) is no doubt a part of the folded margin of the shield. Three segments are observable in the abdominal or caudal series (*c*).

As before stated, Dr. Scouler's specimen has been completely decorticated, and being in a harder and more compact matrix. has undergone a greater amount of mineral change than the specimen obtained by Mr. Bennie.

This example (Fig. 3) presents us with an almost perfect dorsal aspect of the carapace fully spread out upon the shaly matrix, and still retaining the delicate and peculiar ornamentation of the surface (see Plate XVI. Fig. 3).

The carapace is less rounded than in the preceding species (*D. testudinea*); the outline of the lateral margins is elliptical, the latero-anterior angles are rounded, the front border only slightly depressed near the centre;[1] the posterior angles curve slightly inwards, and are then produced into two pointed spines (10 mm. in length), one at each angle; the hinder border is truncated, and was doubtless furnished with a median spine, as seen in Scouler's original specimen, Fig. 2*p*, but it is not preserved in this example.

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[1] See Murchison's "Siluria," 4th edition, 1867. p. 236, fig. 66, and footnote. See also GEOL. MAG., 1865, Vol. II. p. 401, Pl. XI. Fig. 1.

[2] For "anterior" read *posterior*.

[3] *For* "posterior" read *anterior*.

The general surface of the carapace is marked by minute angular plicæ. The dorsal ridge extends from the posterior border for three-fourths of the length of the carapace, and is marked by numerous small but elevated transverse wrinkles.

Two ridges similar in ornamentation to the dorsal ridge arise about 4 mm. distant on either side of the median line, for one-third of their course; passing from near the frontal border, where they are more strongly marked, they continue in a sinuous line towards the posterior margin of the carapace, and are only faintly seen for the remaining two-thirds of their length.

Two medio-lateral ridges, distant about 15 mm. from the dorsal ridge, traverse the carapace on either side, forming two very prominent and strongly marked lateral keels, which stand out in bold relief 4 mm. above the general surface of the shield, and are ornamented with similar transverse wrinkles. Two short and curved ridges (Fig. 3*s*), also ornamented by transverse wrinkles, 10 mm. in length, mark the summits of two well-defined rounded prominences, situated on either side within the frontal border of the carapace, 10 mm. from the dorsal line. Each ridge resembles in curve a long *ſ*, being rounded and deeply circumscribed at its posterior extremity, which is marked on the summit by a minute transverse reniform depression 1 mm. long. These short ridges (Fig. 3 *s*) doubtless serve internally as *points d'appui* for the attachment of the maxillary muscles.

The external border is in great part removed, displaying the finely striated ventral margin; but where it is preserved, it exhibits the same oblique striation described by M'Coy as ornamenting the border of his *D. Scouleri.*[2] The margin is well defined, and about two mm. in breath.

There is evidence upon both the specimen and counterpart that the integument composing the lateral margins of the carapace was double, as in the shield of recent *Apus*, *Limulus*, and other Crustacea; the infolded border being 10 mm. wide near the middle of the margin, and very delicately striated upon its surface. (A minute specimen perhaps belonging to this species (*D. tricornis*), 15 mm. in length, and 10 mm. in breadth, exhibits the same infolding of the lateral margins as the large example displays.)

There are remains of three caudal or abdominal segments, and parts of the tail-spines, the former ornamented with transversely divaricating raised lines, the latter with longitudinal striæ. Length,

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[1] Not deeply emarginated, as in *D. Scouleri*, M'Coy.

[2] M'Coy, Carb. Foss. Ireland, p. 163, pl. xxiii. fig. 2. There seems no reason to doubt that this species is synonymous with *D. testudineus*, with which it should now be merged.

35 mm.; breadth, 16 mm.; greatest breadth of carapace, 65 mm.: length along dorsal line, 55 mm.; from front border to tip of lateral spine, 65 mm.

Locality.—Kirktonholm Cement Works, E. Kilbride, in shale over the Calderwood Cement Stone; Lower Carboniferous Limestone Group. Collected by Mr. J. Bennie.

(*To be continued.*)

EXPLANATION OF PLATE XVI.

[*All the figures on this Plate are of the natural size.*]

FIG. 1.—*Dithyrocaris testudinea*, Scouler. Carboniferous Limestone series, east of Paisley.

FIG. 2.—*Dithyrocaris tricornis*, Scouler. Carboniferous Limestone Series near Glasgow.

In this specimen the caudal segment (*c*) and tail-spines have been displaced and are seen protruding from the latero-anterior border of the carapace.

The two maxillæ are plainly to be discerned at (*g*); they agree in form precisely with those already figured and described by H. Woodward (see GEOL. MAG., 1865, Vol. II. p. 401, Plate XI.); they have also been figured in Portlock's Geological Report on Londonderry (pl. xii. fig. 6).

The carapace in this specimen has been folded together, the under portion protruding from the anterior end at (*a*), the median spine of the posterior border is seen at (*p*), and the two spines marking the latero-posterior angles are thus brought closely together.

Figs. 1 and 2 are drawn from Dr. Scouler's original type specimens, lent to H. Woodward for examination by the Trustees of the Andersonian Museum, Glasgow.

FIG. 3.—A nearly perfect carapace of *D. tricornis*, lying spread out upon the matrix, so as to display the normal outline of the shield; the caudal segments (*c*) are detached, but lie near to the posterior border (*p*). Lower Carboniferous series, East Kilbride. Coll. Geol. Survey Scotland, Edinburgh.

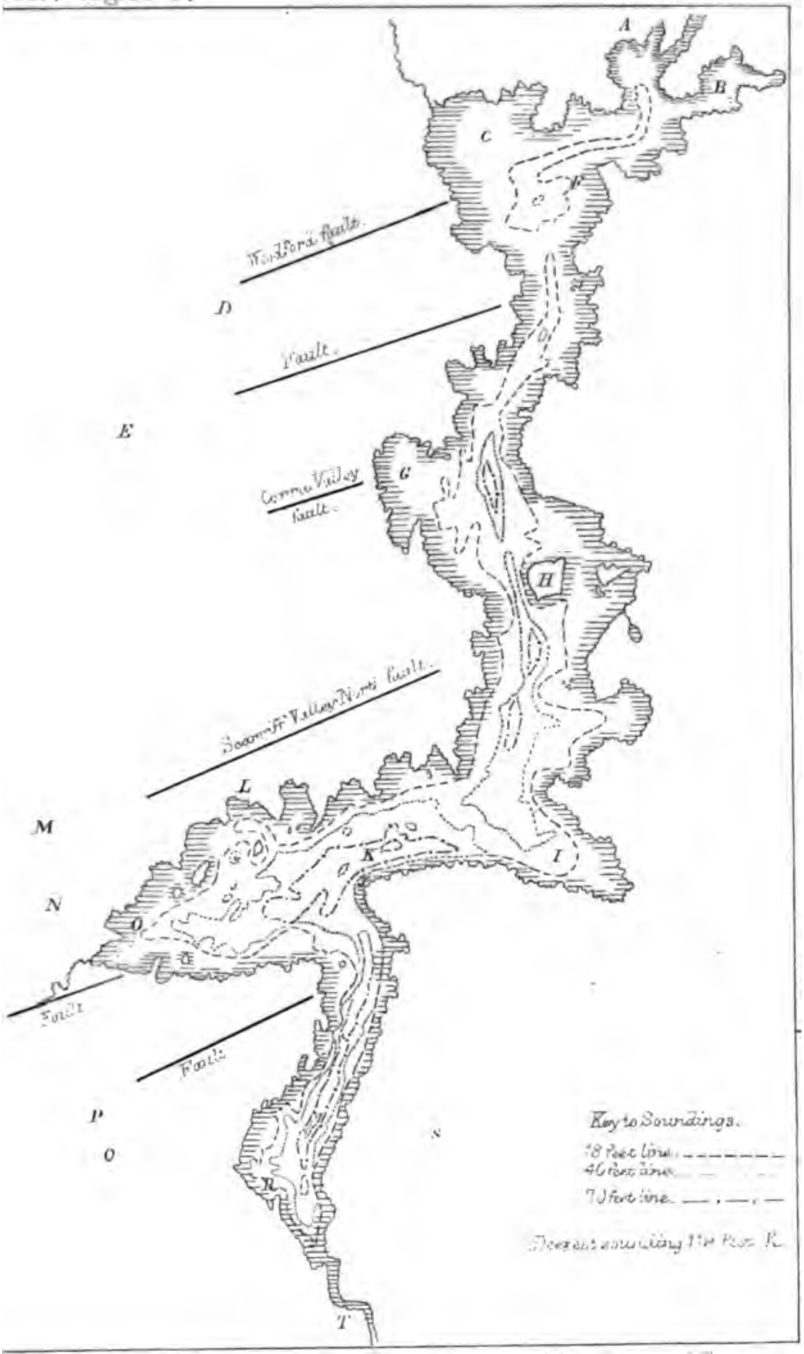
III.—THE WATER BASIN OF LOUGH DERG, IRELAND.

By G. HENRY KINAHAN, M.R.I.A., etc.

(PLATE XVII.)

SOME time since, I read before the Geological Society of Glasgow a paper on "The Valley of Loch Lomond." and pointed out that the deeps and shallows corresponded with the faults and breaks in the adjoining country. This paper was quoted by His Grace the Duke of Argyll, President of the London Geological Society. in opposition to the view (so ably advocated by Professor Ramsay) that ice has been the principal, if not the only, agent engaged in the formation of such hollows.

It was suggested that my observations in this case may have been hastily made; but the valley of Loch Lomond is not the only water basin that I have examined with the help of the Admiralty Charts. I have carefully coutoured the chart of Loch Fyne, also in Scotland: while in Ireland I have contoured those of Loughs Mask, Corrib and Derg; also the chart of the fjord called Killery Harbour, Cos. Galway and Mayo, with those of Cork Harbour, and of the archipelago between Crookhaven and Roaring-water Bay, Co. Cork. In all of these I find a remarkable coincidence between the lines of faults or breaks and the deep soundings; while my colleague, E. T. Hardman, F.R.G.S.I., finds a similar connexion between the faults and deeps in the basin of Lough Neagh, and Mr. John Ball, F.R.S., Geol. Mag. 1873. Vol. X. Pl. XVII.



J.R. DeWilde. [illegible]

Sketch Map of Lough Derg, Ireland.

as shown (Geol. Mag., 1871, Vol. VIII. p. 359, Pl. X.) that either water nor ice alone could have formed the bed of the Lake f Como. In this paper I propose to describe the form of the water asin of Lough Derg, with the features of the principal portions of he adjoining country, and to put forward suggestions as to how the ake basin could have been formed.

Country about Lough Derg.

Lough Derg is one of the large sheets of water through which he River Shannon flows. Formerly its dimensions must have been onsiderably larger; now, however, they are curtailed in places by ccumulations of alluvium and bog, especially towards the northast. The larger division of the lake basin, extending from its orthern extremity at Portumna to the long east and west reach between Youghal and Scarriff bays, is in Carboniferous Limestone; while a smaller division, forming the south-west arm of the lake near Killaloe, is in slates and grits of Silurian age. The country on the east of the larger division cannot be satisfactorily investigated, as the rocks are all so similar, and in places so obscured by drift or bog, that it is nearly impossible to prove faults; however, it is evident that every bay or creek at the eastern side of the lake lies on a line of break. Youghal Bay, farther south, is known to occupy a line of fault, while in the country on the west of the lake various large faults were proved while working the geology. On this side of the Shannon are two groups of hills, called respectively Slieve Bernagh and Slieve Aughta. The northern portion of the first lies west of the smaller division, on the south-west arm of Lough Derg, and the latter lies west of the larger division, the two groups being separated from one another by the Scarriff Valley.

In the northern portion of Slieve Bernagh no great faults can be positively proved, although it is probable there are at least two; but in connexion with Slieve Aughta six nearly east and west faults have been proved by the Government Survey, each associated with a valley or marked feature. They may be called, beginning towards the south, 1st. The *Scarriff valley north fault*, 2nd. The *Cloonnagro and Corra valley fault*, 3rd. The *Lough Atorick valley fault*, 4th. The *Derrybrian valley fault*, 5th. The *Owennaglanna and Boleyneendorrish valley fault*, and 6th. The *Dalystown river valley fault*. These faults, from 1 to 4 inclusive, are downthrows to the southward, while numbers 5 and 6 have downthrows to the northward. All of them are of Post-Carboniferous age, and they, as well as others farther south, probably belong to one system, and were formed simultaneously. The relations between them and the features of the ground were carefully studied during the progress of the Geological Survey, as will appear from the following epitome of the description in the Survey Memoirs.

In Slieve Aughta there is only one large north and south valley, that of Lough Graney; but the east and west valleys are numerous, and lines of faults have been proved in each. These latter valleys can be traced across the mountains from the limestone country on the west, eastward into the limestone country bordering Lough Derg, but the associated faults could only be proved to have shifted the beds a couple of feet. The series of faults seen in this district are mainly made evident by the presence of such different kinds of rocks now in juxtaposition, although they were originally several hundred feet apart; the dark blue limestones and the yellow and red Old Red rocks occurring on one side of the fault, while the grey and green Silurian rocks are found on the other. In places some of what are here considered faults might possibly be only Silurian cliffs, at the base of which the Old Red Sandstones and Limestones were deposited, as the rocks seem to strike with the line of fault. This is more especially the case with the Cloonnagro and Corra faults. But that they are really lines of dislocation seems most probable, as there are so many of them in nearly parallel lines; also the basal beds of the "Old Red" on the upthrow and downthrow sides are similar, which would scarcely be the case if they were lines of cliffs.

Bounding the south of Slieve Aughty is the Scariff valley, which has its accompanying fault on the north of the valley, running from Feakle Lower to Mount Shannon, the Carboniferous Limestone and the Silurian rocks being brought together a little east of the hamlet called [illegible]. This fault was observed a mile and a half S.E. of Feakle, and from that it was traced by [illegible] toward the east; it appears to extend into Lough Derg, but no positive proofs of its existence were found further than the Bow River.

Another valley runs from Lough [illegible] into the catchment basin of Lough Graney at Lough Ea, and from Lough Ea down the Corra River to Lough Graney; while from Lough Graney it extends eastward along the Corra and Derrygoolin rivers to the flat country near Lough Derg; leaving the Lough Graney catchment basin on the north of Arleven. The accompanying fault can be traced from near [illegible] Lough to Arleven, being very conspicuous in the Corra River and near the village of Cloonnagro.

A third valley extends along the Hollymount River to Lough [illegible], to the east of which it crosses the watershed of the catchment basin of Lough Graney, and proceeds down the Drumandoora River to Lough Graney. East of the last-mentioned lake, it is occupied by the Bleach and Woodford Rivers. The accompanying fault lies a little to the north, and has been proved from Carheeny Lough to Corlea Bridge, and from Woodford to Lough Derg; but between Corlea and Woodford it was not ascertained, as the country is covered with deep drift and bog. At Corlea the Carboniferous Limestone is brought down against the Silurian rocks; near Woodford, the limestones and sandstones are thrown against one another; while on the shore of Lough Derg the unstratified portion of the Lower Limestone is brought down against the stratified part. From Corlea to Carheeny the fault is well marked, and divided into two branches on the west of the village of Linnaght. A branch also appears to run eastward from Lough Atorick; this, however, could not be proved.

A fourth valley extends from Lough Cooter along the Owendalulleegh to Marble Hill, a well-marked fault having been traced nearly the entire distance. The fault has its greatest throw in the Derrybrian valley, immediately south of the hamlet called Derrylaur, eight miles east of Gort; but at Chevy-chase the throw is also considerable, as there the limestone is now in juxtaposition with the Silurians or the basal conglomerate of the Old Red Sandstone.

A fifth valley extends across Slieve Aughta, a little north of the summit of Cashlaundrumlahan, in connexion with which there is also a fault, as we find in the Owennaglanna valley Lower Limestone shales, whose south outcrop could not anywhere be found. These rocks are probably bounded on the south by a fault, as farther west in the Boleyneendorrish river-valley there is another outlier of Lower Limestone shale, which has been proved to be bounded on the south by a fault; but as the country on the south of the Owennaglanna is so covered by deep drift and bog, no positive proofs of a fault can there be obtained.

Another fault in connexion with a valley in Slieve Aughta was proved across the low country N.E. of Dalystown, and in the eastern part of the Dalystown river-valley. A little on the north of the village of Tynagh, this fault brings up a small tract of Old Red Sandstone. It has been proved towards the north-east as far as Hearnsbrook, and S.W. into the Dalystown river valley.[1]

LOUGH DERG.

Lakes in a Carboniferous Limestone country are usually very irregular in outline, and, at first sight, it might be supposed that there was no connexion between their shapes and the structure of the subjacent rocks. On examination, however, it is generally apparent that the bays and all wide stretches across the basins conform with the strike of lines of breaks or displacements in the adjoining country, while the minor features of the coast lines are due to the weathering along minor breaks, joint systems, or lines of bedding, more generally one or other of the first two; the basin of Lough Derg prominently illustrates these facts.

On examining the chart of Lough Derg,[2] it is evident that by a few displacements the lake basin might again be made to occupy a nearly N.N.E. and S.S.W. valley; also that each displacement that has shifted the primary valley out of this bearing coincides more or less closely with the strike of the valleys and faults in Slieve Bernagh and Slieve Aughta. (*See Sketch Map,* Pl. XVII., *compiled from the Ordnance and Admiralty Maps.*) This will be apparent from the following general description. Beginning at the south, the bearing of the lake from Killaloe to Rinnaman Point is nearly N. and S.; here a change occurs, but no fault has been proved in connexion with it. North of Rinnaman Point, the deeps for four miles extend S.S.W. and N.N.E., where they are probably crossed by a fault which changes their bearing. This fault is not marked on the Government

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[1] Memoirs and Maps, Geological Survey, Sheets 115, 116, 124, and 125.

[2] Admiralty Chart, No. 1552, Lough Derg, Ireland.

Map, because, as previously stated, it could not be positively proved: but that it does exist seems probable, on account of the position of the Old Red Sandstone in the hill N.E. of the Corragoe Valley. North of this supposed fault the deeps run nearly N. and S., till they unite with the deeps of the previously-mentioned east and west reach that forms part of the lake between Scarriff and Youghal Bays. This long reach lies in the eastern continuation of the Carboniferous Limestone valley that separates Slieve Bernagh from Slieve Aughta, and the limestone seems to be brought into its present position not only by a synclinal curve, but also by faults. On the north of the valley, a large fault with a downthrow to the southward (the Scarriff valley north fault), is quite apparent; while on the south of the valley one or two lines of breaks or faults appear to exist. Within the valley itself they could not be positively proved, on account of the great accumulation of drift and bog at the base of the north slopes of Slieve Bernagh, but farther east in the low country, one of these, with a downthrow to the north, is conspicuous, and in its strike are found the principal deeps in the long east and west reach of Lough Derg. At this reach the lake basin extends eastward over three miles,[1] but north of the entrance into Youghal Bay, the deeps extend N.N.E. to a little south of Illaunmore, where they are crossed by the strike of the Scarriff valley north fault. Immediately north of this strike the deeps bear N. and S., but farther north, east of Cooso Bay, the great deeps (over 70 feet) terminate at the place where the lake basin is crossed by a line in the strike of the Cloonnagro and Corra valley fault. To the northeastward of Cooso Bay, the trough of the lake basin runs nearly N.E. and S.W. to off Drominagh Point, where the strike of the fault, supposed to run nearly E. and W. from near Lough Atorick, crosses it. This fault also is not marked on the Government Maps, as it was not positively proved; but that it does exist seems suggested by the sudden jump in the direction of the associated rocks and the large springs along its line. Still farther northward, an east and west reach extends between Cloondavaun and Terryglass Bays in the line of the strike of the fault proved at Woodford (Lough Atorick valley fault). North of Terryglass Bay the lake basin originally extended much further in a general N.N.E. direction, and its relations to the other faults mentioned in connexion with Slieve Aughta could be pointed out; as, however, this part is now silted up, it may be passed over. We have now mentioned the principal breaks that have apparently shifted and changed the primary valley, all of which are *Post-Carboniferous* and probably *Pre-Glacial;* there are, however, others of a minor rank, many of which seem to be Post-Glacial, which have more or less affected the outline of the lake. They must, however, be passed over; for as yet the Post-Glacial faults have had very little attention paid to them.

Lough Derg is one of the natural reservoirs on the Shannon, and during floods its waters are muddy, while at other times there is a great evaporation from its large expanse of surface; consequently large depositions of mud and marl are continually taking place: therefore the nature of the original bottom of the lake-basin cannot be learned from the soundings; but we do learn that all the deeps are in the lines of the different longitudinal or transverse breaks, or at the junction or crossing of two or more; while most, if not all, of the islands, rocks, shoals, or shallows, are on the upthrow sides of the different faults. The latter fact is very apparent, except in the long reach between Scarriff and Youghal Bays, as the existence of the faults to the south of the Scarriff valley have not as yet been proved. If, however, as is highly probable, the previously-mentioned fault in the plain on the west of that valley extends through it and into the long reach, all the deeps in that part of the lake-basin are on the downthrow side of this fault. In concluding this portion of the paper it may be observed, that if faults or breaks have no connexion with the formation of lake-basins, it appears remarkable that in this basin all the changes in the bearings of the different lines of deeps should be connected with the strikes of the different faults in Slieve Bernagh and Slieve Aughta, and that the islands, rocks, and shallows should be on the upthrow sides of these lines of faults.

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[1] This east and west valley might possibly shift the N.E. and S.W. valley about three miles towards the eastward; but it is more probable that this second nearly north and south portion of the lake basin was excavated along a nearly parallel fault line to that along which the first portion was formed.

SUPPOSED FORMATION OF THE LAKE-BASIN.

We have now only to offer suggestions as to how the "rock basin" of Lough Derg was excavated; for although its water is now in most places margined with drift or alluvium, yet the probability is that it was originally almost, if not entirely, surrounded by rocks.

The faults and breaks were probably developed at such times as the land was rising from under water, in which case the sea must have been the first excavator, marking out along those faults and breaks valleys and ravines, which were afterwards occupied by rivers and ice; for when the sea retired, these other denudants must have accomplished more or less work. It has been pointed out by Prof. J. S. Newberry, M.D.,[1] in relation to some of the large North American lakes, that the original surface outlets from them have been apparently obliterated by large accumulations of drift, and thereby the waters have been forced to find other outlets; and this probably may also have been the case in regard to the basin of Lough Derg, as the valley extending from Youghal Bay round the hills called Slieve Arra, and down the Kilmastulla River to the Shannon, a few miles south of Killaloe, is now occupied by a deep accumulation of drift. This drift, which is principally gravel and sand, apparently of the "Esker sea period" may be of sufficient depth to fill a valley whose original trough corresponded with the height of the rocky barrier that forms the rapids and falls of Doonass, in the neighbourhood of Castleconnel; and if such a valley ever existed, either marine action or meteoric abrasion would have been capable of excavating the basin of Lough Derg to a depth of about sixty feet below the present surface of the water. Such a passage would be able to drain all the upper part of the lake basin, except four small deeps: one northward of Illaunmore, one immediately west of that island, and two to the S.S.W. of it; but it would be incapable of draining a portion of the long east and west reach and a long narrow tract in the south-west arm of the lake, they being over sixty feet in depth, while in places they are over 100 feet; one spot which is situated in the former, a little on the north-east of Parker's Point, being 119 feet deep.

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[1] "On the Surface-Geology of the Basin of the Great Lakes, and the Valley of the Mississippi," by Prof. Newberry, M.D., U.S. Geologist. Ann. Lyceum Nat. Hist., New York, 1869, vol. ix. See GEOL. MAG., 1870, Vol. VII. p. 227.

In the paper on "Soundings in the Lake of Como," referred to in the introduction, Mr. Ball has pointed out as to a lake basin, "supposing the rocks on either side to be of equal hardness, and similarly stratified, it is safe to affirm that if they had been hollowed out by glacial action, or by aqueous erosion, the slope would be steepest on the concave side of the bend in those parts of the lake where the glacier stream was turned aside from its previous direction." Mr. Ball has shown that this is not the case in the basin of the Lake of Como; neither is it the case in the Lough Derg basin; as at all such bends the slopes are steepest at the convex side of the bends, while the deepest part of each cross-section is nearest to the same side. If, however, the rocks were broken up in lines by breaks and faults, ice would act along such lines and lift up and carry away rocks, excavating some places, where the rocks were broken, much more deeply than either marine action or ordinary meteoric abrasion could do.[1] Such deeps would be nearest to the convex sides of the bends, as the natural action of the ice would excavate away the higher rocks in the section more toward the concave than toward the convex side.

Ice, however, could scarcely excavate or gouge out the sudden deep holes that occur in so many lake-basins; to which I would add, that after carefully contouring and examining the Charts of the lakes and bays mentioned in the introduction, I am convinced that the sudden deep holes could not have been excavated by the sea, ice, or ordinary meteoric abrasion; but as all of them seem to occur on breaks, or at the junction of two or more dislocations, it appears inevitable that they are due, at least in part, to fissures formed by the contraction and displacement of the rocks; while subsequently most, if not all of them, may have been connected with subterranean streams, which at different times drained, or helped to drain, the lake-basins. Ice, when it first forms on a country, will be more or less full of foreign matter, viz. the broken rocks and other detritus that occur at the surface; after a time, however, all these will be carried away; so that if the Lough Derg basin had been for ages occupied by ice, most, if not all, of the loose portions would have been removed out of it, leaving the ice, prior to its final disappearance, comparatively speaking, pure, and without any rock detritus in it, to incumber the lake basin; therefore, none of the deeps in it could have been filled with drift. At the present time, the deepest spot in Lough Derg is only eleven feet below the low-water of ordinary spring-tides at Limerick; but as the level of the lake is 108 feet higher, there would even now be an underground drainage if any of these holes are connected with subterranean passages. During the Glacial Period, if the land was higher than at present, the water would find vents through such passages, denuding away their walls and enlarging the deeps from which it flowed. After the Glacial Period water would still flow through them, until eventually the land sank so low that they were incapable of acting; or even previous to this, they might be choked by successive depositions of mud and marl. Even now there are reasons for supposing that some such passages may exist out of Lough Derg, as in the summer less water leaves the lake at Killaloe than flows into it by the main river at Portumna and from the numerous other smaller feeders; part of this deficit is certainly due to evaporation, but the whole of it could scarcely be thus accounted for.

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[1] The Rev. M. H. Close is of opinion that "there never was 'a glacier' in the basin of Lough Derg. That basin, however, was no doubt swept by a flow of the general ice-covering of the country."

Many of the Irish lake basins, especially those in the Carboniferous Limestone, which now have a surface drainage, may once have had subterranean vents. This appears probable from the various systems of lakes connected with subterranean rivers that still exist in different places in the island, and we would call especial attention to those connected with the River Fergus, Co. Clare, since a system of lakes somewhat similar to this may have formerly existed in the basin of Lough Derg. These lakes are of considerable size and are irregularly situated, and the river is thus described by the late Mr. F. J. Foot, "The River Fergus rises in Lough Fergus, between Corrofin and Ennistimon, at an elevation of about 350 feet above the sea, flows eastward and northward for two miles and a half, when it receives the Clooneen river; thence it takes an easterly course for a mile and a half, when, on entering the limestone ground, it suddenly disappears in a swallow-hole or vertical cavity in the rock. Half a mile to the east, it again emerges to the light, from a cavern called Poulnaboe, from which it flows down into Inchiquin Lough and thence into Lough Atedaun. No visible river flows out of this Lough, but the Fergus is supposed to have a subterranean course in a direction of about E.S.E. to Dromore Lough, whence it flows southward, now above and now below ground, to Ennis, and thence to the Shannon." In the basin of Lough Derg, if the deeps below the 50-feet line of soundings were mapped, they would make a system very similar to those connected with the River Fergus, and the similarity would be more complete, if each deep was connected with its fellows by subterranean passages; while the great deep (119 feet) in the long east and west reach had a passage from it to the sea somewhere in the neighbourhood of Limerick.

I have now offered suggestions as to the mode of formation of the basin of Lough Derg; they are antagonistic to the views entertained by many persons; still they appear to me more reasonable than any others; and the physical agencies appealed to are all either such as have been by common consent admitted to have been at work in former times, or such as can be seen in operation at the present day.

EXPLANATION OF SKETCH MAP (PLATE XVII.) OF LOUGH DERG.

A	Portumna.
B	Terryglass Bay.
C	Cloondavaun Bay.
D	Woodford.
E	Slieve Aughta.
F	Drominagh Point.
G	Coose Bay.
H	Illaun More.
I	Youghal Bay.
J	Parker Point.
K	Deepest sounding (119 feet).
L	Mountshannon.
M	Coolcoosaun.
N	Scarriff.
O	Scarriff Bay.
P	Cornagnoe Valley.
Q	Slieve Bernagh.
R	Rinnaman Point.
S	Slieve Arra.
T	Killaloe.

IV.—ON THE NORTHERLY EXTENSION OF THE OLD RED SANDSTONE TO LINLEY, AND OTHER GEOLOGICAL FEATURES OF THE VALLEY OF LINLEY BROOK.

By JOHN RANDALL, F.G.S.

TWO remarkable geological features present themselves in this little valley: one, the occurrence of the Upper Coal Measures of Bewdley, together with the well-known *Spirorbis* Limestone; the other, that of the Bone-bed, succeeded by the no less interesting Passage-beds, forming connecting links between the Old Red Sandstone and Upper Ludlow Limestone. The order in which these occur, taking both banks of the brook, appears to be this.

1. Upon the surface, beds of drift, with boulders, of various thickness.
2. The Permians may be seen dipping rapidly away from the younger Coal Measures, which crop out from beneath them, together with the *Spirorbis* Limestone, which occurs between the two coals.
3. Coarse sandstones, with "coal sheds," as the Shropshire sinkers term them.
4. Followed by Red clays, about six feet.
5. Light coloured grits, with plant remains, twenty feet.
6. Hard micaceous, gritty and flaggy sandstones, with fish remains, first discovered in collecting materials for my "Severn Valley," in 1860, and described as "The Upper Bone-bed" in a paper prepared by the late George Roberts, F.G.S., and myself, and read before the Geological Society by Professor Ramsay, January 21st, 1863.[1]

The bed occurs on both sides the valley, and the spines, solid ribs, and solid bones it yielded are stated by Sir Philip Egerton to be the largest of the forms figured by him from the corresponding bed at the Paper Mill, Ludlow.

The sandstones of the "Upper Bone-bed," are altogether about seven feet in thickness, but the Bone-bed itself is not more than two inches; and—

7. Underneath it is a kind of flagstone, one foot nine inches thick, with very interesting and distinct impressions of current or ripple marks.

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[1] See Quart. Journ. Geol. Soc., 1863, vol. xix. p. 229.

8. Followed by eleven inches of micaceous sandy grits, with *Lingulæ*.

9. Greenish, irregularly laminated rock with conglomerate, one foot.

10. Hard calcareous grit, with thickly disseminated grains, and many broken *Lingulæ*, twelve inches.

11. Succeeded by twenty feet of laminated light grey micaceous grit; and—

12. Lastly, about six feet of micaceous sandy clays coloured by peroxide of iron.

These are the lowest traceable in the glen or gorge, where the first Bone-bed occurs, and they are succeeded, I imagine, although the connexion is not to be very distinctly traced, by the yellowish sandstone seen beneath the yew-trees higher up the brook, which is probably of the Downton series. It contains *Beyrichiæ* and *Lingulæ*, the former in abundance, and in one or two ferruginous bands may be found dermal scutes of *Thelodus*, with fragments of *Lingulæ*.

The "Lower Bone-bed" then occurs in the bed of the brook, in conjunction with a hard calcareous rock containing numerous clusters of *Modiolopsis complanata* at its base; and to these succeed flaggy beds of impure limestone containing *Serpulites longissimus* and other Upper Ludlow forms, followed by the Aymestry series, which, however, become much better developed on the sides of the Caughley division of Darley Brook, a stream entering the Severn a few hundred yards higher up, and where characteristic fossils such as *Rhynchonella Wilsoni*, *Rhynchonella spherica*, *Chonetes lata*, with others, are to be found.

Among the fish fauna of these beds, Sir Philip Egerton has distinguished remains of *Onchus*, *Plectrodus*, *Ctenacanthus*, and I think others.

It is worthy of remark that *Plectrodus*, *Onchus* and *Ctenacanthus* abound most as characteristic of this zone, and that at Ludlow the Crustacean remains of *Pterygotus* predominate, while at Ledbury the Cephalaspid fishes seem to have been the chief inhabitants of the water.

The "Upper Bone-bed" is interesting as connected with the extreme northerly extension of one great section of the Old Red Sandstone, which, following an uninterrupted course from South Wales, through Herefordshire and South Shropshire, and attaining a thickness of several thousand feet, here dwindles down to the compass indicated, and speedily disappears altogether.

Similar "Bone-beds," with Devonian and Silurian passage shales, have been found in Herefordshire, Worcestershire, and Gloucestershire, the latter at Pyrton Passage, a point about 70 miles distant from Linley.

Whether these beds, which are never more than a foot in thickness, and more frequently are not more than one or two inches, are absolutely continuous or not over all the intervening spaces between the points indicated, there is no evidence to show. In either case they point to a uniformity of conditions over large areas, and indicate that were such depositions took place, they must have been of precisely the same character.

The two beds, here separated by the grits, and rock and shales described, comprising about forty feet of strata altogether, become highly interesting when considered as the connecting links between two great formations, and as prolific in the remains of those forms of ichthyic life now engaging so much of the attention of palæontologists. In his second edition of "Siluria," Sir R. Murchison, describing rocks occupying similar positions, says, "Fourteen years have now elapsed since I proclaimed that these fishes of the Upper Ludlow rock appeared before geologists for the first time as the most ancient beings of their class; and all the subsequent researches in the various parts of the world over which Silurian rocks have been found to extend have failed to add to or modify this generalization. In other countries, indeed, besides our own, as in America and Bohemia, one or two ichthyolites have been discovered within the pale of Silurian rocks; but there, as with us, they are merely found on the outer threshold of the system, and very sparingly."

Whether such beds are evidences of sudden destruction of the finny inhabitants of these early waters, or merely indicate conditions favourable to fish life—like modern feeding grounds on shallow shelving shores—I cannot say; but leaving the question as to the cause of this accumulation, nothing is more easy than to read by aid of the light which such remains afford the conditions under which these passage-beds themselves were formed.

First, there was the period of clear water, when lime alone was thrown down; next, that during which rivers came down charged with sand containing iron, so fatal to fish life; but with intervals when clear water prevailed, as evidenced by the Corn-stones. Speaking of these sandstones, Sir H. de la Beche, in the Memoirs of the Geological Society, says, "In the country of which Herefordshire forms the chief portion, extending to Shropshire in one direction, to Monmouthshire and Glamorganshire in another, and into Brecknockshire, Caermarthenshire, and Pembrokeshire in a third, we have an unbroken exposed surface of 2100 square miles of Old Red Sandstone; the whole, making due allowance for vertical differences between the upper and lower beds, of the same general character. Taking the average thickness of the mass as it appears from measuring the beds vertically to their out-crop, we should have more than 1500 cubic miles of chiefly red-coloured detrital matter, for such it appears, with the exception of a slight amount of the limestones termed Corn-stones. We have hence in this area alone a large amount of detritus accumulated under conditions very different, as regards the admixture of ferruginous matter, from those which preceded it during the Silurian epoch. It is difficult to obtain a clear view, in the present state of our knowledge, of the causes which produced such a mixture of peroxide of iron with the accumulations formed during the lapse of time apparently required for the deposit of this amount of Old Red Sandstone. After a few sandstone beds with *Lingulæ*, and perhaps some other shells—the last struggles, as it are, of the molluscs of the time to keep their ground in the waters vering this area—there would appear to be few other traces of imal life than the remains of fishes, and these chiefly in the Corn-ones, or limestones, associated with the red or variegated marls and ndstones. Fishes could readily swim freely without injury in the ters from which the peroxide of iron was thrown down, so long they did not disturb the substance at the bottom, while at the ne time molluscs would be incapable of crawling upon or living the sand or mud intermingled with the peroxide, as we have found experiments; so that at any intervals when the waters might be ieved by deposit from their load of mechanically suspended per-de of iron, the fish could readily enter the area exposed to this d of red accumulation." Seeing that there is no break or onformity in these two sets of rocks, the Upper Ludlow and the l Red rocks, but that the physical passage from one to the other by se stratigraphical beds is uniform and complete, it is difficult to ount for the life break which takes place in passing from one for-tion to the other, excepting on the ground that great changes in relative positions of land and water must have taken place, sing the marine condition of an extensive area most probably to re become one of fresh-water, seeing that the remains found ong to the latter, and that marine forms did not live on beyond limits of these passage-beds. The marine Silurian sea must have n slowly and gradually changing at the time these beds were med by elevations and oscillations of the land over an oval basin-ped region, extending from this northern point to Haverford-West l Milford Haven, in South Wales, on the one side, and along the berley and Malvern ranges, and the eastern margin of the Bristol al-field on the other. Over this large area during long intervals time fresh-water conditions, estuarine or lacustrine, with slow but tinuous elevation of land, are supposed to have continued, for no m of invertebrate life appears to have lived on beyond these beds,[1] ich form the confines of the two systems.

Clearly, an entire change took place in the marine fauna as we low through this series of beds from the Ludlow Limestone the conformable Lower Old Red Sandstone, when the few fish d crustacea common to them almost, if not entirely, disappeared; the vast accumulation of these sandstones in this district marks epoch and an era almost barren of life; only two or three species, d these land and fresh-water, being found, and they only in the per portions of the Old Red.

In supposing this section of Old Red Sandstone to have been piled under fresh-water rather than marine conditions, I have adopted views of Mr. Robert Etheridge, F.R.S., who holds that an exten-e coast-line or barrier existed south of the Mendip Hills, separat-it from the fossiliferous marine Devonians, which he divides into niddle, lower, and upper series.

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[1] We assume the author means life *in this particular area;* he does not of course ly that no form of invertebrate life passed from the scene of the older into that the newer deposit.—Edit. Geol. Mag.

No such passage-beds here conduct us from the Old Red Sandstone to the Coal Measures, and even in cases where they do, as in North Devon, of the 383 species of Devonian fossils known in Great Britain and Ireland, only 56 are common to it and the Carboniferous series, which contain 1748—a fact which would seem to indicate either very varied conditions or a wide difference in point of time. The abruptness and suddenness of the change in passing from the Old Red to the Coal Measures is all the greater from the fact that here we rise from the former formation into the upper members of the Coal Measures; and the question naturally arises as to whether the old Coal Measures ever here rested upon the Old Red Sandstone, now capped by the New. Facts occur which indicate that they did; and supposing the Old Red to have been the result of the silting up of the wide area indicated, it will occur to the mind that conditions were preparing for the growth of vegetation, by the formation of land.

It is worthy of remark, too, that on the high ground at Linley, by the road-side, traces of the old or Lower Coal Measures occur, as well as on the high ground before descending the hill at the Dean, where an anticlinal fault brings up the Aymestry Limestone. Still stronger evidences are furnished by the facts that at Shirlot and the Brown Clee Hills the connexion between the two is distinct. The evidence is equally conclusive that they have been swept away altogether here, partially so to the north, at the Dunge, where the 'Little Flint Coal' crops out above, and the 'Lancashire Ladies,' the lowest coal of the series, occurs a little below the road. At Caughley, in the Deep pit, and in other shafts on that side, the younger coals, together with the *Spirorbis* Limestone, overlap the lower measures of the old coal-field. At Caughley the *Spirorbis* Limestone appears on the surface, and is found in several old shafts in the neighbourhood, about 180 feet above the Crawstone, the lowest Ironstone of the series; thus showing that the Coal Measures up to the top coal have been destroyed. The extent to which these were reduced, and the point at which denudation ceased, is marked by what is called 'calamincar' and the rough rock, the latter very uneven and irregular in thickness, but a complete conglomerate, having above it the usual brick and tile making clays of the neighbourhood, with a clunch, and one, or sometimes two, thin seams of coal above. The order in which these coals disappear, as we gather from practical men connected with the district, is this:—At the foundry, midway between Broseley Town Hall and the church, what is known on this side the river as top coal terminates, whilst the bottom coal extends thirty yards further, and then terminates too. The Pennystone then runs two hundred yards beyond, and terminates at the Foresters' Arms, on the road to Ironbridge; the Vigor coal five yards further on, and the Ganey coal a hundred yards beyond the latter. The Clod coal extends thirty yards further than the Best, the next in succession, and the Little Flint coal sixty yards further still. This would represent about a hundred and fifty-two feet of vertical, and 1575 feet of [illegible] strata, giving a slope of one in a little over ten, as the old coast-line. Towards the bottom of the Estuary the slope appears to be less, for at Caughley, over a mile from the last point named, the Clod coal, and the Little Flints, occasionally are found; but no trace of them, as we have seen, is to be found at Linley Brook. How far the extension of the Clod and Little Flint coals to Caughley, beyond where we might naturally expect them to terminate, may be due to a downthrow fault which intervenes, we cannot say; but a great fault crosses the road which lets down the brick and tile clays which are on the surface, by Mrs. Thorn's brickworks, so that at the deep pits near they are worked at a depth of ninety yards.

If we follow the course of the Severn to the south, and examine the rocks laid bare in the valley, and in channels cut by tributary streams on either side, we not only find all traces of the older Coal Measures disappear, but we find the younger members come in and supply their place.

If we cross the 16 miles area, consisting of the usual divisions of the Permian, the Bunter, and Keuper sandstones, which separate the coal-fields of Coalbrookdale and South Staffordshire, we find no indications of the existence of the Coal Measures underneath; on the contrary, the experiments made at Enville, Shatterford, and other places, demonstrate their absence.

That the Shropshire and South Staffordshire coal-fields are fragments of one mineral tract would appear from the position which that important and persistent measure—the Pennystone Ironstone—occupies in the two fields, as well as from the similarity of its organic remains. The authors of the memoirs of the Geological Survey, in their "Iron Ores of Great Britain," say that the lower beds of the Coal Measures in South Wales and Shropshire (and the same is true for Lancashire) contain a set of marine fossils, some of which are Mountain Limestone species, and the rest peculiar to the Coal Measures. Also, that there seem to be good reasons for supposing the Rosser veins of South Wales equivalent to the Pennystone and underlying ironstones of Coalbrookdale; that the flat coal bass has at least a very strong resemblance in its fish-remains to the bottom vein; and that the Darran Pins exactly resemble the white flats of Coalbrookdale; whilst the Ellea Balls Mine is the counterpart of the ball stone of the same field. If the various beds of these coal-fields can be correlated, and if it is reasonable to suppose that the mineral seams originally extended over the greater portion of the intermediate tracts where we know they no longer exist, the extent to which they have been denuded is amazing.

Still, when we look at the island-like form of the Brown Clee Hills, rising above the sea of Old Red Sandstone, and bearing on its summit a narrow patch of the Lower Coal Measures—a mere wreck saved by the protecting barriers of trap and other rocks from that utter destruction which befell the coal-seams spread over tracts where now no trace exists—the mind is the more disposed to believe in the destruction of the Coal Measures from the eastern side of the Shropshire field to the western side of that of South Staffordshire and East Worcestershire.

We know that deposition and denudation are inseparable correlatives, and that the amount of destruction done upon the older rocks is measured by the sedimentary deposits derived from their materials; but the recognition of these facts gains more than ordinary significance when we come to consider of how much of those hidden mineral treasures we prize so highly, and the extension of which we seek so earnestly, as the means of perpetuating our national prosperity, we have been deprived by the former agency.

Along the line of ground marked by the barrier before referred to as separating the marine Devonians from the fresh-water Old Red Sandstones of this district, Palæozoic rocks are described as crumpled and contorted for a breadth of many miles, and along a length of 800 miles, tilting and turning the Coal Measures back upon themselves, squeezing and folding them, so that the crown of the anticlinal is sometimes four or five miles above the level of the reversed synclinal arch to which the bottom Coal Measures descend in Belgium. One of these anticlinals presents itself at Linley, on a small scale it is true, but bearing the unmistakable impress of the forces to which it is due, and betraying to the experienced eye the direction in which denudation has done its work. All such tilted beds must have had broken edges somewhere, and those edges once exposed to the waves, the work of denudation would commence along the line of fracture.[1]

V.—NOTES ON THE BRITISH GRAPTOLITES AND THEIR ALLIES.

By CHAS. LAPWORTH, F.G.S.

1.—ON AN IMPROVED CLASSIFICATION OF THE RHABDOPHORA.

PART I.

IN the following communication I intend to give a very brief outline of some of the chief results of my investigations among British Graptolites in those departments of inquiry which are more especially connected with consideratious of classification. I shall content myself with offering a concise statement of the main conclusions at which I have arrived, reserving all detail to the future, when I hope to adduce decisive evidence in support of the views here advanced. The special subjects to be noticed in this place are—the development, structure, classification, and geological distribution of that section of the *Rhabdophora* in which the complete polypary can be proved to be composed of one or more polyparies essentially similar to that in the unilateral and uniserial forms to which the name Graptolites (Graptolithus) is commonly applied. Those *Rhabdophora* supposed to be similar in structure to the genus *Retiolites* will be considered in conjunction, but no pretension is made to anything like the same certainty in this section. In an outline paper like the present, which may be looked upon simply as a registration of new discoveries and opinions, it becomes possible to dispense with that constant reference to the collateral labours of other investigators which strict justice demands in a work of detail. All who are likely to be interested in these conclusions will notice at a glance what is original, and what has been derived from the discoveries and speculations of previous observers.

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[1] Read before a Field-meeting of the Dudley Geological Society, held at Linley near Bridgnorth, on 17th September, 1873.

DEVELOPMENT.

A careful study and comparison of great numbers of young Graptolites from the Moffat Shales, belonging to the genera *Dicellograptus*, *Dicranograptus*, *Pleurograptus*, *Leptograptus*, *Diplograptus*, etc., has induced me to conclude that in all the bilateral and duplex species the mode of development is essentially the same. The polypary of every species which I have been able to trace satisfactorily through the earlier stages of its existence, first becomes visible as a small pointed, triangular—or rather dagger-like—"germ," which from its constant and characteristic shape I have denominated the *sicula*.[1] In the majority of the species examined the sicula is at first exceedingly minute, but it sometimes attains a length of one-fourth of an inch before it undergoes any perceptible alteration of its external aspect. The first visible change consists in the development of a solid axis in its outer wall, extending along its entire length, and prolonged as a naked filiform process beyond one or both of its extremities. A small protuberance or bud[2] next makes its appearance upon one of the lateral margins, usually in the immediate neighbourhood of the major extremity of the sicula, and this is gradually moulded into a theca. A similar bud is then given off from the opposite margin, but slightly in advance of the former, and from these primordial buds the two main branches of the polypary are slowly evolved by a process of continuous gemmation.

The mode of growth here described certainly obtains in most of the species appertaining to the genera named above. In *Cœnograptus* and *Nemagraptus*, however, the primordial buds are given off midway between the two extremities of the sicula. In *Dichograptus* and its allies it is yet uncertain whether the remarkable non-polypiferous "funicle" peculiar to this group is formed from true buds, or whether it is not rather a dichotomising outgrowth of the major extremity of the sicula. The sicula itself normally ceases to grow after the primordial buds have originated. In rare examples of *Diplograptus* it seems to be imbedded in the proximal portion of the polypary. In a few dibrachiate species it is absorbed or becomes obsolete in old age; but in the great majority of cases it permanently retains the shape it possessed at the period of the commencement of the lateral branches, and forms a very conspicuous feature in the adult organism. It is simply this persistent sicula which constitutes the "axillary spine" in *Dicellograptus*, the "radicular bar" in *Cœnograptus*, and the "radicle" in *Didymograptus* and *Phyllograptus*, etc.

In some cases, however, the sicula most certainly increases in size after the branches have been thrown off. In the genus *Leptograptus* and its nearest allies it is frequently developed into a third and central branch, and examples of *Diplograptus* afford evidence that it may possibly grow even more rapidly than the branches, and give origin to that terminal "vesicle" which forms so extraordinary an appendage in a few species.

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[1] The *sicula* is probably identical with that portion of the polypary which Herr Richter has termed the "*foot*." See Appendix.

[2] See Appendix.

I have not yet been able to work out the development of the unilateral Graptolites (*Monograptidæ*) so fully in consequence of the generally minute size of the *sicula*. I am unable to say whether the polypary in these species extends along the sicula as in *Diplograptus*, or whether it does not simply originate from its minor extremity, in the manner of the central branch in *Leptograptus*. Should the latter prove to be the true method of development, this circumstance, read in conjunction with the facts to be presently noticed in connexion with the vertical range of the Graptolites, enables us to summarise the foregoing conclusions under the following general rule.

In the earliest siculate Graptolites known (*Dichograptus*, etc.), the polypary originates from a dichotomising outgrowth from the major extremity of the sicula; in the second type (*Diplograptus*, etc.), it is formed from two opposite buds thrown off from the lateral margins in the immediate neighbourhood of the major extremity; in the third type (*Cœnograptus*, etc.) the two buds arise from points equidistant from both extremities; in the fourth stage (*Leptograptus*, etc.), in addition to the two lateral branches, a third branch is formed by the continued outgrowth of the minor extremity of the sicula; and finally in the last and most modern type (*Monograptus*, etc.), the two lateral buds are apparently wanting, and the polypary is developed from the minor extremity alone.

The "angle of divergence" (sicular or dorsal angle) of the two main branches of the bilateral Graptolites, varies throughout the complete circle. It may be 0°, in which case the branches grow parallel with each other distally along the line of the sicula, and coalesce by their dorsal surfaces, either for the whole of their length (*Diplograptus*), or for a portion of it only (*Dicranograptus*). It may be less than 180° (*Dicellograptus*); it may exceed 180° (*Didymograptus*); or it may be as high as 360°, when the branches again coalesce (*Phyllograptus*). When the sicular angle is less than 180°, the proximal end of the complete polypary is formed by the major extremity of the sicula; and when it exceeds 180°, it is formed by its minor extremity.

STRUCTURE.

The common portion of a polypary of *Monograptus* preserved in relief appears to be composed simply of the conjoined bases of the successive thecæ (chambers). These bud from each other in a single linear series. The budding orifices remain permanently open, and form together a continuous longitudinal tube or canal of communication for the conveyance of the common body. The line of junction of these chambers can be traced on all examples preserved in the round, completely to the virgula, which lies imbedded in a narrow groove impressed on the dorsal walls of the chambers. The line of junction is naturally thickened, and projects into the common canal as a rounded shelf or flange. It will obviously be found convenient in practice to restrict the application of the term *theca* to the exterior and separable portion of the chamber,—in other words, to that which is capable of being broken off from the common portion. There is, however, no constriction or line of separation at the proximal extremity of the theca so limited, but the distinctness of each chamber is clearly visible upon the common portion itself. The natural elevation of the central parts of these chambers within the boundaries of the common canal is the cause of that peculiar waviness of the dorsal edge of the compressed polypary, which has been noticed in a few monoprionidian species. Indeed, in some forms, this elevation is so pronounced, even in the neighbourhood of the virgula, that the dorsal margin appears toothed or denticulated in the manner of a saw.

In the duplicate forms the polypary is merely composed of two of these monoprionidian polyparies placed back to back. Their dorsal walls are flattened, and coalesce into a median septum, between the two laminæ of which, the duplicate virgula (which is apparently formed by the united virgulæ of the composing branches) lies imbedded. The flattening of the dorsal walls is never carried so far as completely to obliterate the distinctness of the common portions of the chambers, but the adherent faces are bent by their mutual appression into a series of waves, answering exactly in number and position to the thecæ. The two branches are so fitted together that their thecæ constitute a double alternating series in the duplicate polypary. It is this circumstance, in combination with the natural prominence of the central parts of the proximal portions of the chambers, that gives to the suture the remarkable undulation, which, conspicuous in only a very few species, is, in all probability, a structural necessity in the whole of the siculate *Diprionidæ.*

The Moffat examples of the genus *Climacograptus* of Hall, preserved in a state of relief, place beyond a doubt the duplicate nature of the polypary in this genus, as first pointed out and subsequently so ably contended for by Professor Nicholson. A very slight pressure applied along the line of the septum in these specimens is sufficient to cause the polypary to fall apart longitudinally, and thus expose to view the continuous flattened walls, the imbedded virgula, etc., as described by him, while the distinctness of the thecæ may be placed beyond question by their being easily broken off the common canal one by one, and individually examined. Compressed examples of *Climacograptus* are sometimes procured, in which the moieties have fallen asunder for a greater or less extent previous to fossilization, and specimens are not infrequent, both in this genus and *Diplograptus*, in which it seems clearly evident that the composing polyparies must have had different rates of growth.

The form *Climacograptus typicalis* (H.), examined and described by Prof. Hall (Grapt. Quebec. Group, p. 28), may possibly belong to the genus *Lasiograptus*, to be noticed hereafter.

In addition to the great section of the siculate *Diprionidæ*, there is a second section, embracing the genus *Retiolites* and its allies. Such observations as have hitherto been made on the structure of the

[illegible]

[illegible]

[illegible]

represent the dawn of organic life. Into the reasons which led Barrande to include the rocks of the first, second and third faunas in one Silurian system (a view which was at once adopted by the British Geological Survey and by Murchison himself), it is not our province to inquire; but we desire to call attention to the fact that the latter, by his own principles, was bound to reject such a classification. In his address before the Geological Society in 1842 (already quoted in the first part of this paper), he declared that the discussion as to the value of the term Cambrian involved the question "whether there was any type of fossils in the mass of the Cambrian rocks different from those of the Lower Silurian series. If the appeal to nature should be answered in the negative, then it was clear that the Lower Silurian type must be considered the true base of what I had named the Protozoic rocks; but if characteristic new forms were discovered, then would the Cambrian rocks, whose place was so well established in the descending series, have also their own fauna, and the Palæozoic base would necessarily be removed to a lower horizon."

In the event of no distinct fauna being found in the Cambrian series, it was declared that "the term Cambrian must cease to be used in zoological classification, it being, in that sense, synonymous with Lower Silurian." (Proc. Geol. Soc., vol. iii. p. 641, et seq.) That such had been the result of palæontological inquiry Murchison then proceeded to show. Inasmuch as the only portion of Sedgwick's Cambrian which was then known to be fossiliferous was really above and not below the Llandeilo rocks, which Murchison had taken for the base of his Lower Silurian, his reasoning with regard to the Cambrian nomenclature, based on a false datum, was itself fallacious; and it might have been expected that when the Government Surveyors had shown his stratigraphical error, Murchison would have rendered justice to the nomenclature of Sedgwick. But when, still later, a farther "appeal to nature" led to the discovery of "characteristic new forms," and established the existence of a "type of fossils in the mass of the Cambrian rocks different from those of the Lower Silurian series," Murchison was bound by his own principles to recognize the name of Cambrian for the great Ffestiniog group, with its primordial fauna, even though Barrande and the Government Surveyors should unite in calling it Primordial Silurian.

He however chose the opposite course, and now attempted to claim for the Silurian system the whole of the Middle Cambrian or Ffestiniog group of Sedgwick, including the Tremadoc slates and the Lingula-flags. The grounds of this assumption, as set forth in the successive editions of *Siluria* from 1854 to 1867, and in various memoirs, may be included under three heads: first, that the Lingula-flags have been found to exist in some parts of his original Silurian region; second, that no clearly-defined base had been assigned by him to his so-called system; and third, that there are no means of drawing a line of demarcation between these Middle Cambrian formations and the overlying Llandeilo.

polypary in these puzzling forms, afford evidence that in these genera both series of thecæ open into a sub-central common canal, and that the various parts of the polypary are strengthened by slender chitinous threads connected with the virgula. Nothing further seems needed to show that these collectively form a very distinct group from that already noticed.

Among the species usually classed with *Diplograptus* are two extraordinary types which seem to merit generic distinction. It is, moreover, impossible at present to reconcile their general structure with the previous interpretation of that of the siculate *Diprionidæ*. In the first of these types, which includes *Diplograptus spinulosus* (H.) and its allies, not only is each theca furnished with two long spines or fibres, extending outwards from the angles of the aperture, but the polypary itself is ornamented in addition with two opposite longitudinal rows of gigantic, isolated spurs, developed along the median line of the periderm at right angles with the thecæ. The polypary in these forms is first visible as a small oval disc, bristling with a host of incipient spurs, and is in its later stages, ornamented with a greatly extended single (?) filiform virgula. The generic term *Glossograptus* was proposed for a form of this group by Dr. Emmons in 1855, and although the designation can hardly be considered appropriate now that the true form of the polypary is known, yet it ought obviously to be retained.

In the adult polypary of the species of the second type, a slender spine is developed from the outer margin of each theca. At a small but constant distance outside the general boundary of the polypary, this spine subdivides into (or gives off) numerous minute threads which inosculate with those originating in a similar manner from the spines immediately above and below. These threads form a connected network or braid almost completely surrounding the polypary. Perfect examples are excessively rare, but the specimens belonging to the group can be recognized at once, their margins being apparently furnished with minute tufts of tangled hairs. The species of this type I propose to unite in a provisional genus under the title of *Lasiograptus* (Gr. λάσιος, hairy, shaggy).

THE ANALYTICAL TABLE OF THE GENERA OF GRAPTOLITES, embodying the foregoing conclusions, together with the Appendix (already referred to), containing descriptions of new genera, will appear in the December Number.

VI.—HISTORY OF THE NAMES CAMBRIAN AND SILURIAN IN GEOLOGY.[1]

By Prof. T. STERRY HUNT, LL.D., F.R.S.

(Continued from p. 461.)

WE have already noticed that Barrande, as early as 1852, gave the name of Primordial Silurian to the rocks which, in Bohemia, were marked by the first fauna; although he, at the same time, recognized this as distinct from and older than the second fauna, discovered in the Llandeilo rocks, which Murchison had declared to resent the dawn of organic life. Into the reasons which led rande to include the rocks of the first, second and third faunas one Silurian system (a view which was at once adopted by the tish Geological Survey and by Murchison himself), it is not our vince to inquire; but we desire to call attention to the fact that latter, by his own principles, was bound to reject such a classifi-on. In his address before the Geological Society in 1842 (already ted in the first part of this paper), he declared that the discussion o the value of the term Cambrian involved the question "whether re was any type of fossils in the mass of the Cambrian rocks erent from those of the Lower Silurian series. If the appeal to ıre should be answered in the negative, then it was clear that the ver Silurian type must be considered the true base of what I had ıed the Protozoic rocks; but if characteristic new forms were ›overed, then would the Cambrian rocks, whose place was so l established in the descending series, have also their own fauna, the Palæozoic base would necessarily be removed to a lower izon."

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[1] Reprinted from the "Canadian Naturalist," new series, vol. vi. no. 3, p. 304.

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polypary in these puzzling forms, afford evidence that in these genera both series of thecæ open into a sub-central common canal, and that the various parts of the polypary are strengthened by slender chitinous threads connected with the virgula. Nothing further seems needed to show that these collectively form a very distinct group from that already noticed.

Among the species usually classed with *Diplograptus* are two extraordinary types which seem to merit generic distinction. It is, moreover, impossible at present to reconcile their general structure with the previous interpretation of that of the siculate *Diprionidæ*. In the first of these types, which includes *Diplograptus spinulosus* (H.) and its allies, not only is each theca furnished with two long spines or fibres, extending outwards from the angles of the aperture, but the polypary itself is ornamented in addition with two opposite, longitudinal rows of gigantic, isolated spurs, developed along the median line of the periderm at right angles with the thecæ. The polypary in these forms is first visible as a small oval disc, bristling with a host of incipient spurs, and is in its later stages, ornamented with a greatly extended single (?) filiform virgula. The generic term *Glossograptus* was proposed for a form of this group by Dr. Emmons in 1855, and although the designation can hardly be considered appropriate now that the true form of the polypary is known, yet it ought obviously to be retained.

In the adult polypary of the species of the second type, a slender spine is developed from the outer margin of each theca. At a small but constant distance outside the general boundary of the polypary, this spine subdivides into (or gives off) numerous minute threads, which inosculate with those originating in a similar manner from the spines immediately above and below. These threads form a connected network or braid almost completely surrounding the polypary. Perfect examples are excessively rare, but the specimens belonging to the group can be recognized at once, their margins being apparently furnished with minute tufts of tangled hairs. The species of this type I propose to unite in a provisional genus under the title of *Lasiograptus* (Gr. λάσιος, hairy, shaggy).

THE ANALYTICAL TABLE OF THE GENERA OF GRAPTOLITES, embodying the foregoing conclusions, together with the Appendix (already referred to), containing descriptions of new genera, will appear in the December Number.

VI.—HISTORY OF THE NAMES CAMBRIAN AND SILURIAN IN GEOLOGY.[1]

By Prof. T. STERRY HUNT, LL.D., F.R.S.

(*Continued from p.* 461.)

WE have already noticed that Barrande, as early as 1852, gave the name of Primordial Silurian to the rocks which, in Bohemia, were marked by the first fauna; although he, at the same time, recognized this as distinct from and older than the second fauna, discovered in the Llandeilo rocks, which Murchison had declared to represent the dawn of organic life. Into the reasons which led Barrande to include the rocks of the first, second and third faunas in one Silurian system (a view which was at once adopted by the British Geological Survey and by Murchison himself), it is not our province to inquire; but we desire to call attention to the fact that the latter, by his own principles, was bound to reject such a classification. In his address before the Geological Society in 1842 (already quoted in the first part of this paper), he declared that the discussion as to the value of the term Cambrian involved the question "whether there was any type of fossils in the mass of the Cambrian rocks different from those of the Lower Silurian series. If the appeal to nature should be answered in the negative, then it was clear that the Lower Silurian type must be considered the true base of what I had named the Protozoic rocks; but if characteristic new forms were discovered, then would the Cambrian rocks, whose place was so well established in the descending series, have also their own fauna, and the Palæozoic base would necessarily be removed to a lower horizon."

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[1] Reprinted from the "Canadian Naturalist," new series, vol. vi. no. 3, p. 304.

In the event of no distinct fauna being found in the Cambrian series, it was declared that "the term Cambrian must cease to be used in zoological classification, it being, in that sense, synonymous with Lower Silurian." (Proc. Geol. Soc., vol. iii. p. 641, et seq.) That such had been the result of palæontological inquiry Murchison then proceeded to show. Inasmuch as the only portion of Sedgwick's Cambrian which was then known to be fossiliferous was really above and not below the Llandeilo rocks, which Murchison had taken for the base of his Lower Silurian, his reasoning with regard to the Cambrian nomenclature, based on a false datum, was itself fallacious; and it might have been expected that when the Government Surveyors had shown his stratigraphical error, Murchison would have rendered justice to the nomenclature of Sedgwick. But when, still later, a farther "appeal to nature" led to the discovery of "characteristic new forms," and established the existence of a "type of fossils in the mass of the Cambrian rocks different from those of the Lower Silurian series," Murchison was bound by his own principles to recognize the name of Cambrian for the great Ffestiniog group, with its primordial fauna, even though Barrande and the Government Surveyors should unite in calling it Primordial Silurian.

He however chose the opposite course, and now attempted to claim for the Silurian system the whole of the Middle Cambrian or Ffestiniog group of Sedgwick, including the Tremadoc slates and the Lingula-flags. The grounds of this assumption, as set forth in the successive editions of *Siluria* from 1854 to 1867, and in various memoirs, may be included under three heads: first, that the Lingula-flags have been found to exist in some parts of his original Silurian region; second, that no clearly-defined base had been assigned by him to his so-called system; and third, that there are no means of drawing a line of demarcation between these Middle Cambrian formations and the overlying Llandeilo.

With regard to the first of these reasons, it is to be said that the only known representatives of the Lingula-flags in the region described by Murchison in his *Silurian System* are the black slates of Malvern; and some scanty outliers which, in Shropshire, lie between the old Longmynd rocks and the base of the Stiper-stones. The former were then (as has already been shown) supposed by him to belong to the Llandeilo, or rather to the passage-beds between the Llandeilo and Cambrian (Bala); while with regard to the latter, Ramsay expressly tells us that they were not originally classed with the Silurian, but have since been included in it. (Mem. Geol. Surv., vol. iii. part 2, page 9; and 242, foot-note.)

The Llandeilo beds were by Murchison distinctly stated to be the base of the Silurian system (*Sil. Syst.* p. 222); and it was farther declared by him that in Shropshire (unlike Caermarthenshire) "there is no passage from the Cambrian to the Silurian strata," but a hiatus, marked by disturbances which excluded the passage-beds, and caused the Lower Silurian to rest unconformably upon the Longmynd rocks. (*Ibid.* p. 256; and plates 31, sections 3 and 6: 32, section 4.) But in *Siluria* (1st ed. p. 47) the two are stated to be conformable; and in the subsequent sections of this region, made by Aveline, and published by the Geological Survey, the evidences of this want of conformity do not appear. Murchison at that time confounded the rocks of the Longmynd with the Cambrian (Bala) beds of Caermarthenshire and Brecon. (*Sil. Syst.* p. 416.) Hence it was that he gave the name of Cambrian to the former; and this mistake, moreover, led him to place the Cambrian of Caermarthenshire beneath the Llandeilo. It is clear that if he claimed no well-defined base to the Llandeilo rocks in this latter (their typical region), it was because he saw them passing into the overlying Bala beds. There was, in the error by which he placed *below* the Llandeilo, strata which were really *above* them, no ground whatever for afterwards including in his Silurian system, as a downward continuation of the Llandeilo rocks (which are the basal portion of the Bala group), the whole of the Ffestiniog group of Sedgwick; whose infra-position to the Bala had been shown by the latter long before it was known to be fossiliferous.

It was, however, claimed by Murchison that no line of separation can be drawn between these two groups. The results of Ramsay and of Salter, as set forth in the address of the former before the Geological Society in 1863, and more fully in the Memoirs of the Geological Survey (vol. iii. part 2) published in 1866, with a preface by himself, as the Director of the Survey, are completely ignored by Murchison. The reader familiar with these results, of which we have given a summary, finds with surprise that in the last edition of *Siluria,* that of 1867, they are noticed in part, but only to be repudiated. In the five pages of text which are there given to this great Middle Cambrian division, we are told that the distinction between the Lower Tremadoc and the Lingula-flags "is difficult to be drawn," and that the Upper Tremadoc slate passes into and forms the lower part of the Llandeilo, "into which it graduates conformably." (Siluria, 4th ed. p. 46.) In each of these cases, on the contrary, according to Ramsay, there is observed "a break very nearly complete both in genera and species, and probable unconformity;" the evidence of the palæontological break being furnished by the careful studies of Salter; while that of the stratigraphical break, as we have seen, leaves no reason for doubt. (Mem. Geol. Surv., vol. iii. part 2, pp. 2, 161, 234.) The student of *Siluria* soon learns that in all cases where Murchison's pretensions were concerned, the book is only calculated to mislead.

The reader of this history will now be able to understand why, notwithstanding the support given by Barrande, by the Geological Survey of Great Britain, and by most American geologists, to the Silurian nomenclature of Murchison, it is rejected, so far as the Lingula-flags and the Tremadoc slates are concerned, by Lyell, Phillips, Davidson, Harkness and Hicks in England, and by Linnarsson in Sweden. These authorities have, however, admitted the name of Lower Silurian for the Bala group or Upper Cambrian of Sedgwick—a concession which can hardly be defended, but which apparently found its way into use at a time when the yet unravelled perplexities of the Welsh rocks led Sedgwick himself to propose, for a time, the name of Cambro-Silurian for the Bala group. This want of agreement among geologists as to the nomenclature of the Lower Palæozoic rocks, causes no little confusion to the learner. We have seen that Henry Darwin Rogers followed Sedgwick in giving the name of Cambrian to the whole Palæozoic series up to the base of the May Hill Sandstone; and the same view is adopted by Woodward in his Manual of the Mollusca. The student of this excellent book will find that in the tables giving the geological range of the mollusca, on pages 124, 125 and 127, the name of Cambrian is used in Sedgwick's sense, as including all the fossiliferous strata beneath the May Hill Sandstone. On page 123 it is however explained that Lower Silurian is a synonym for Cambrian, and it is so used in the body of the work.

The distribution of the Lower and Middle Cambrian rocks in Great Britain may now be noticed. The former, or Bangor group, to which Murchison and the Geological Survey restrict the name of Cambrian,. and which they sometimes call the Longmynd, bottom or basement rocks, occupy two adjacent areas in Caernarvon and Merionethshire; the one near Bangor, including Llanberris, to the north-east, and the other, including Harlech and Barmouth, to the south-east of Snowdon; this mountain lying in a synclinal between them, and rising 3571 feet above the sea. The great mass of grits or sandstones appears to be at the summit of the group, but in the lower part the blue roofing-slates of Llanberris are interstratified in a series of green and purple slates, grits and conglomerates. (Some of the Welsh roofing-slates are however supposed to belong to the Llandeilo.) (Mem. Geol. Surv., vol. iii. part 2, pp. 54, 258.) The Harlech rocks in this north-western region are conformably overlaid by the Menevian, followed by the true Lingula-flags, or *Olenus* beds, of the Middle Cambrian. Upon these repose the Tremadoc slates, which are not known in the other parts of Wales. The third area of Lower Cambrian rocks is that already described at St. Davids in Pembrokeshire, about 100 miles to the south-west; and the fourth that of the Longmynd hills, about sixty miles to the south-east of Snowdon. The rocks of the Longmynd, like those of the other Lower Cambrian areas mentioned, consist principally of green and purple sandstones with conglomerates, shales and some clay-slates. They occasionally hold flakes of anthracite, and small portions of mineral pitch exude from them in some localities. The only evidence of animal life yet found in the rocks of the Longmynd are furnished by worm-burrows, the obscure remains of a Crustacean (the *Palæopyge Ramsayi*), and a form like *Histioderma*. This latter organic relic, with worm-burrows, and the fossils named *Oldhamia*, is found on the coast of Ireland opposite Caernarvonshire, in the rocks of Bray Head, which resemble lithologically the Harlech beds, and are regarded as their equivalents.

Still another area of the older rocks is that of the Malvern hills, on the western flanks of which, as already mentioned, the Lingula-flags are represented by about 500 feet of black shales with *Olenus*, underlaid by 600 feet of greenish sandstones containing traces of fucoids, with *Serpulites* and an *Obolella*. It is not improbable, as suggested by Barrande and by Murchison, that these 1100 feet of strata represent, in this region, the great mass of the Lingula-flags,—and we may add perhaps the whole series of Lower Cambrian strata which in Caernarvonshire and Pembrokeshire underlie them; since these sandstones of Malvern, like those of St. Davids, rest upon crystalline schists, and are in part made up of their ruins.

These crystalline schists of Malvern, which are described by Phillips as the oldest rocks in England, and by Dr. H. B. Holl are conjectured to be Laurentian, seem from the description of their lithological characters to resemble those of Caernarvon and Anglesea, with which they are, by Murchison, regarded as identical. The crystalline schists of these latter localities are, by Sedgwick, described as hypozoic strata, below the base of the Cambrian. Murchison however, in the first edition of his *Siluria*, adopted the suggestion of De la Beche that they themselves were altered Cambrian strata. In fact they directly underlie the Llandeilo rocks, and were apparently conceived by Murchison to represent the downward continuation of these, upon which he had insisted. This opinion is supported by ingenious arguments on the part of Ramsay. (Mem. Geol. Surv., vol. iii, part 2, passim.) I am however disposed to regard them, with Sedgwick and Phillips, as of pre-Cambrian age, and to compare them with the Huronian series of North America, which occupies a similar geological horizon, and with which, as seen in Northern Michigan, and in the Green Mountains, I have found the rocks of Anglesea to offer remarkable lithological resemblances.

It may here be noticed that the gold-bearing quartz veins in North Wales are found in the Menevian beds, and also, according to Selwyn, throughout the Lingula-flags. These fossiliferous strata at the gold-mine near Dolgelly appear in direct contact with diorites and chloritic and talcose schists, which are more or less cupriferous, and themselves also contain gold-bearing quartz veins. (Mem. Geol. Surv., part 2, pp. 42, 45; and Siluria, 4th ed., pp. 450, 547.)

The Table on p. 510 gives a view of the Lower Palæozoic rocks of Great Britain and North America, together with the various nomenclatures and classifications referred to in the preceding pages. In the second column, the horizontal black lines indicate the positions of the three important palæontological and stratigraphical breaks signalized by Ramsay in the British succession. (Mem. Geol. Surv., vol. iii. part 2, p. 2.) In a table by Davidson in the GEOLOGICAL MAGAZINE for 1868 (Vol. V. p. 305), showing the distribution of organic remains in these lower rocks, he gives, as the Ffestiniog group of Sedgwick, only the Dolgelly and Maentwrog beds of Belt (the Upper and Middle Lingula-flags); and makes of the two divisions of the Tremadoc rocks a separate group; the whole being described as the Upper Cambrian of Sedgwick. This, however, is not the present grouping and nomenclature of Sedgwick, nor was it his earlier one. So far as regards Middle and Upper Cambrian, this discrepancy is explained by the fact already stated, that, in 1843, Sedgwick proposed, as a compromise, the name of Cambro-Silurian for his Bala group, previously called Upper Cambrian; by which change the Ffestiniog or Middle Cambrian became Upper Cambrian. When the true relation between the Lower Silurian of Murchison and the Bala group was made known, Sedgwick, as we have seen, re-claimed for the latter his former name of Upper Cambrian; but this had meanwhile been adopted for the Ffestiniog group, in which sense it is still used by Lyell, Phillips, Davidson, Harkness, and Hicks. The Ffestiniog group, or Middle Cambrian, as defined by Sedgwick, however, included not only the whole of the Lingula-flags, but the Upper and Lower Tremadoc rocks. (Philos. Mag., IV. vol. viii. p. 362.)

The only change which I have made in the groupings of the British rocks adopted by Sedgwick and Murchison is in separating the Menevian or Lower Lingula-flags from the Ffestiniog, and uniting it with the Bangor group or Lower Cambrian. In this I follow, with Lyell and Davidson, the suggestion of Salter and Hicks.

In the third column, the sub-divisions are those of the New York and Canada Geological Surveys; in connexion with which the reader is referred to a table published in 1863, in the *Geology of Canada*, p. 932. Opposite the Menevian I have placed the names of its principal American localities; which are Braintree, Mass., St. John, New Brunswick, and St. John's, Newfoundland. With regard to the classification of Angelin, it is to be remarked that although he designates II. as *Regio Olenorum*, and III. as *Regio Conocorypharum*, the position of these, according to Linnarsson, is to be reversed; the *Conocoryphe* beds with *Paradoxides* being below and not above those holding *Olenus*. The *Regio Fucoidarum* in Sweden has lately furnished a Brachiopodous shell, *Lingula monilifera*, besides the curious plant-like fossil, *Eophyton Linnæanum*. (Linnarsson, GEOL. MAGAZINE, 1869, Vol. VI. p. 393.)

LOWER PALÆOZOIC ROCKS OF EUROPE AND NORTH AMERICA.

	BRITISH SUB-DIVISIONS.	NORTH AMERICAN SUB-DIVISIONS.	NOMENCLATURES OF SEDGWICK AND MURCHISON.	BARRANDE'S CLASSIFICATION.	ANGELIN'S DIVISIONS.
14	Ludlow.	Lower Helderberg.	Silurian, *Sedgwick.* Upper Silurian, *Murchison.*	Third Fauna including Etages H. G. F. E.	VIII. VII. or Regiones E. and DE
13	Wenlock.	Niagara, Clinton, Medina, Oneida.			
12	Upper Llandovery.				
11	Lower Llandovery.	Hudson-River, Utica, Trenton, Birdseye, Black-River.	Upper Cambrian or Bala group, *Sedgwick.* Lower Silurian, *Murchison.*	Second Fauna including Etage D.	VI. V. IV. or Regiones D. C. and BC.
10	Caradoc.				
9	Upper Llandeilo.				
8	Lower Llandeilo.	Chazy. Levis. Calciferous.			
7	Upper Tremadoc.		Middle Cambrian or Ffestiniog group, *Sedgwick.* Primordial Silurian, *Murchison.*	First Fauna or Primordial Fauna, including Etage C, and probably also Etage B.	III. II. I. or Regiones B. and A. and Regio Fucoidarum.
6	Lower Tremadoc.				
5	Dolgelly.	Potsdam.			
4	Maentwrog.				
3	Menevian.	Braintree and St. John.	Lower Cambrian or Bangor group, *Sedgwick.* Cambrian, *Murchison.*		
2	Harlech.	——— ?			
1	Llanberris.	——— ?			

NOTICES OF MEMOIRS.

I.—The Strata below the Trias in the country around Liverpool; and the probability of Coal occurring at a moderate depth. By G. H. Morton, F.G.S. [A Paper read before the Liverpool Literary and Philosophical Society, 1873.]

AFTER mentioning two papers on this same subject by E. W. Binney, Esq., F.R.S., Mr. Morton explains the use of the Government Geological Survey Maps, and gives from them a table of the strata as they occur in the country bordering the Dee and Mersey, in ascending order, viz.:—

PALÆOZOIC.	*Silurian*	Wenlock Shale		
	Devonian	Old Red Sandstone...	100	feet.
	Carboniferous ...	Carboniferous Limestone ...	1200	,,
	,, ...	Millstone Grit	1000	,,
	,, ...	Lower Coal Measures	1800	,,
	,, ...	Middle or Productive Coal Measures	1500	,,
	,, ...	Upper Coal Measures	1200	,,
	Permian	Permian Sandstone...	300	feet.
	,, ...	Permian Marl...	50	,,
MESOZOIC.	*Trias*	Lower Bunter...	400	,,
	,, ...	Pebble Beds	350	,,
	,, ...	Upper Bunter...	400	,,
	,, ...	Keuper Sandstone	450	,,
	,, ...	Keuper Marl	100	,,
	RECENT	Superficial Accumulations ...	50	,,

The Carboniferous strata have in places suffered great denudation. The whole series 6700 feet in thickness has been denuded from the Wenlock Shale of Denbighshire and Flintshire, where it formed an anticlinal curve, and only scattered patches of the Limestone are left at the base to indicate their former position. More to the N.E. there is less elevation, and consequently such a reduced denudation that a fringe of Coal Measures occurs along the S.W. of the Dee. Still further to the N.E., in Wirral, the New Red Sandstone comes in, overlying the Coal Measures, which seem fully developed and undenuded. The Coal Measures continue thus relatively depressed until thrown up by a great fault to the E. of Liverpool, where the Trias and Permian have been denuded.

The author next alludes to several papers, which the present state of the supply of Coal has called forth, and points out that none of them question the occurrence of the Coal Measures beneath the Trias.

The Coal Measures, it seems, however, do not always underlie the New Red Sandstone, as proved by numerous sections in North Wales, where the Carboniferous Strata has been deeply denuded, and in some places entirely removed before the deposition of the Permian and Trias.

This great denudation of the Carboniferous Strata on the S.W. of the Dee has been caused by the upheaval and consequent exposure of the country to denuding influences, while the Coal Measures in the N.E., owing to the remarkable dip of the strata, were protected in a depression, probably beneath the sea.

Mr. Morton next gives four sections tending to prove that the Coal Measures lie fully developed beneath the Trias.

1. Sections at Sutton St. Helens. Here the lowest strata visible are the Upper Coal Measures, dipping at various angles from 6° to 12°; and underlying the Permian, which is supposed to be about 350 feet thick. About five miles N.E. of this locality, at Edge Green, near Wigan, there has been considerable denudation of the Coal Measures; the "*Main Delph Coal*" being reached at a depth of only 475 feet.

2. Section at Halsnead. The section represents a line across the country south of Huyton Quarry. But the succession of the strata is not so distinct as at that place, on account of the land being everywhere covered with drift. The Upper Coal Measures occur here, and seem to be 1200 feet thick. They are succeeded by the Lower Bunter Sandstone, but there is sufficient unproved ground for the Permian to crop out between it and the Upper Coal Measures.

3. Section at Thatt's Heath. Here the Middle Coal Measures are thrown up by a great fault. This dislocation cannot have destroyed any of the strata, being a simple fracture, leaving the order of succession on both sides of the fault unchanged. And since at Sutton, within two miles, the Upper Coal Measures and the Permian are both fuller exposed, these formations, along with the higher Coal-seams above the Ravenshead Beds, and the Permian, have all been denuded, along with the Trias, from off the Middle or productive Coal Measures exhibited in the section.

4. Section at Denna, Little Neston. This intersects the boundary fault between the Bunter Pebble Beds and the Middle Coal Measures. The Upper Coal Measures and probably the Permian have been denuded on the S.W. of the fault, but underlie on the N.E. At Shotwick, about four miles S.E. from Neston, a boring made for Coal proved the Lower Bunter to be 510 feet, and to rest upon the Coal Measures.

From these four sections Mr. Morton infers that there are Coal-fields beneath the Trias, and concludes with a few remarks as to the practicability of working them.—B.B.W.

II.—PROCEEDINGS OF THE BRISTOL NATURALISTS' SOCIETY, vol. vii., part 2, June to December, 1872.—In this little work Mr. E. B. Tawney, F.G.S., records his discovery of *Zoophycus scoparius* (Thollière), a plume-shaped Alga, in the Inferior Oolite of Dundry. This species is, so far as he knows, new to English geology, but it is extremely characteristic of the Inferior Oolite in the Alps of the Canton de Vaud, being sometimes almost the only fossil to be found in those beds. It is also characteristic of the Inferior Oolite (Bajocien) in the South of France.

Mr. Tawney also contributes some notes on the Upper Greensand Fossils in the Bristol Museum.

III.—THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE; AUGUST 20TH, 1873. PORTLAND, MAINE.

NOTES ON THE FRUCTIFICATION OF SIGILLARIA.—At the meeting of the American Association in Portland, Principal Dawson exhibited and described a specimen of *Sigillaria* from Cape Breton, exhibiting zones of marks of fructification on the stems and branches, in the manner of *S. elegans* and *S. Lalayana*, and other species, to which the species in question, *S. Lorwayana*, is closely allied. He pointed out that these fruit-scars are really modified leaf-scars, and that they could not have borne strobites or modified branches, but may have produced single nuts of the nature of *Trigonocarpa*, or flattened racemes of such fruits like *Trigonocarpum racemosum*, or some Antholithes, which seem to be modified leaves with marginal fruits, structurally resembling the fertile leaves of Cycads. These points will be more fully brought out in a forthcoming Report of the Geological Survey of Canada. They confirm the views already stated by the author in his "Acadian Geology," and were supported in the discussion by facts from the Coal-fields of Ohio, stated by Dr. Newberry, and shortly to be published by him in the Reports of the Survey of that State.

REVIEWS.

WHITAKER'S GEOLOGICAL MODEL OF LONDON.

UNTIL within the last twelve months, the work of the Geological Survey in connexion with the surface geology of the London district was unknown to the world at large. The nature of the ground at the surface in any given district of the metropolis and its suburbs, the range and thickness of the loams, gravels, and superficial clays, and the questions of hygienic geology connected with them, were only to be settled by the outside world in an empirical manner, unless the excellent maps and sections by Mr. Mylne gave the desired information. The principle upon which the Survey work has been conducted could hardly be expected to be in advance of the age, and hence, with one exception, the maps of the London district which we have hitherto had have only represented the so-called solid geology of the area. London has suffered largely from this curious division of labour. Until the last year there was no delineation of those important surface accumulations of marine and fluviatile material, varying from ten to twenty feet in thickness, which have such an enormous spread about London, and largely determine the sanitary character of the area, whilst they are also connected with the foremost geological questions of the present day. Within the last few months, however, and for the first time, a complete representation of the geology of London, with all the aids of colour and relief contour, has been produced under the auspices of the Survey. A large block-model, showing both the superficial and solid geology of the metropolis, has been placed in the Museum of Practical Geology in Jermyn Street.

It is the work of Mr. W. Whitaker, B.A., F.G.S., whose Memoir on the Chalk and Eocene Beds of the London Basin is alone a sufficient monument for a geologist to leave behind him. Mr. Whitaker has been admirably seconded in the constructive part of the work by Mr. J. B. Jordan, of the Mining Record Office. The Model is so important in its scientific aspects, and at the same time so pictorial and popular in treatment, as to deserve special recognition and welcome, and a description of its more novel features.

The surface of the Model exhibits the 160 and odd square miles of ground which may fairly be called metropolitan. Near the four corners of this vast residential quadrangle are Hampstead (N.W.), Wimbledon (S.W.), Great Ilford (N.E.), and Shooter's Hill (S.E.). All these places are well within the district represented. The horizontal scale is no less than six inches to the mile—a good liberal allowance, and one which will make the Model of real service for the study and reference of Londoners. The length (E. and W.) is seven and a half feet (15 miles), and the breadth (N. and S.) five and a half feet (11 miles). The excellent six-inch topographical maps of the Ordnance Survey have been coloured geologically by Mr. Whitaker, and fitted on to the plaster contours of the Model. The difference between landscape contours as shown on the plane surface of a map, and the same contours shown in the vertical relief of a model, is one which will be appreciated by that increasing class of the general public who frequent the Jermyn Street Museum for educational purposes.

Owing to the very moderate heights to which the land rises about London, the vertical scale has been exaggerated four times and a half, so as to give 200 feet to an inch. Even with this enlargement, one is struck with the lowness of the hills, or rather undulations, and the depressed appearance of the whole district. That low and solitary mound in the S.E. corner, coloured red, is Shooter's Hill—quite an important eminence in London landscapes. The generally wasted, reduced, and flattened appearance of the entire area conveys its own comment upon the softness of the rocks, and their susceptibility to meteoric agencies—rains, rivers, and frosts.

The Model also shows the subterranean geology of London to a depth of more than 1100 feet. To do this so as to show important points which lie in the centre of the district, an ingenious arrangement has been adopted. The Model has been divided vertically into nine pieces. Of these the inner ones can be hoisted up by simply turning a handle. The pieces thus exposed show us the deeper geology of London at such interesting spots as the Kentish Town well-boring (1113 feet). In every case care has been taken to carry the sections through the most instructive points. All the sections, too, are carried down through the Eocene beds, the Chalk, and the Upper Greensand to the Gault, a point at which our knowledge of London geology is for the present at a stand-still. The total length of the sections drawn (not counting the duplication of some on opposite faces) is over 52 feet, or about 105 miles.

The reason of the persistent growth of London along certain areas in preference to others is made very apparent. Mr. Prestwich, in his admirable Presidential Address to the Geological Society last year, entered into some interesting details to show how unerringly, up to the time of the great Water Companies, the population had followed the great gravel-bed on either side of the Thames. "A map of London so recent as 1817 shows how well defined was the extension of houses arising from this cause. Here and there only beyond the main body of the gravel there were a few outliers, such as those at Islington and Highbury; and there habitations followed. In the same way south of the Thames villages and buildings were gradually extended over the valley-gravels to Peckham, Camberwell, Brixton, and Clapham; while, beyond, houses and villages rose on the gravel-capped hills of Streatham, Denmark Hill, and Norwood. It was not until facilities were given for an independent water supply by the rapid extension of the works of the great Water Companies that it became practicable to establish a town population on the clay districts of Holloway, Camden Town, Regent's Park, St. John's Wood, Westbourne, and Notting Hill." The valley of the Lea shows the same geological causes at work localizing the population in accordance with the primary need of life. A little outside the northern limits of the Model we should find the presence of the gravel-beds indicated by the more or less historical settlements of Hendon, Stanmore, Finchley, Barnet, Totteridge, Whetstone, and Southgate.

The spread of the river-gravels and loams up the gentle slopes of the Thames Valley several miles on either side, and to a height of at least 80 feet, tells its own story as to the former width of the prehistoric river which was the precursor of the present diminished stream. The vivid manner in which the old and not yet obsolete physical geography of the country is pictured is one of the great merits of the Model. Perhaps the great superiority of a model over a plane surface consists in the fact that it puts before us the actual dynamical conditions to which the landscape is subject, and under which the contours of one age are gradually passing into those of another.

The gravels of this part of England form at present an unwritten chapter of Post-glacial geology. Speaking broadly, it may be said that the first term in the series is that accumulation of the Glacial Period which underlies the chalky clay. This deposit (the "Middle Glacial of the South-east of England," as Mr. S. V. Wood, jun., has named it) is the great fund from which the subsequent accumulations in all their varieties have been drawn. But between this genuine glacial gravel (mostly flint, but with foreign rocks and an abundance of the Oxford Clay *Gryphea*) and the valley-gravels, with their remains of Mammoth and Rhinoceros, the process of assortment and removal to lower levels has given rise to local modifications of a marked kind. These local characters which the gravels put on in and around London doubtless represent a long period of great changes in the hydrographical and terrestrial conditions of the country, and open paths of investigation which will be well worth following up. We look forward to the forthcoming

Memoir on the Drifts of the district for a careful classification of the gravels. All that we could look for in the Model is the distinction between the gravel-beds proper and the pebble-beds. Of the latter Shooter's Hill is given us as an example. Like the pebble-beds at Hampstead Heath, Barnet, Totteridge, and elsewhere, it is formed of local materials, and may be, as Mr. Searles Wood, jun., once suggested, a second-hand accumulation of the Bagshot beds. This would agree with the prior date which is assigned to the pebble-beds as against the Glacial gravels. Although they may have been disturbed during the Glacial Period, the pebble-beds have not been adulterated with rocks foreign to the district.

The Thames Valley, as seen in the Model, is in its way a sensation. Whatever may have been the condition of the earlier valley, and whether or not it may have been more symmetrical than now,—as, for instance, when the river was cutting down its bed from the higher to the lower terraces which may be seen at Acton and Ealing to-day,—certainly a very feebly-marked main valley is all that remains for the study of Quaternary geographers. We see before us an extremely wide, irregular, and shallow depression, with no traces of the sides of a containing trough, and a generally ruinous condition of the rocks on either side—a good contrast to those districts of our island where harder rocks narrow and deepen the action of the streams. Nothing but a model can give a true idea of the so-called Thames Valley.

It would greatly add to the value of this Model if a card were affixed to it bearing a few notes on the characteristic landscape contours of the district and their geological causes. Such notes have been already embodied by Mr. Whitaker in the Memoir of the Chalk and Eocene Beds of the London Basin, already referred to, and might well be reproduced in elucidation of the Model. Let the visitor, for instance, refer to the south side of the Model, where Shooter's Hill is shown in vertical section. He will observe that this eminence is an example of the fact that the stratigraphical arrangement of the beds is often the reverse of the contours, and that a geological hill is often in a geographical trough. Let him compare this fact with the following note: "When the beds have been thrown into the form of a trough or basin, be it ever so gentle, there they oppose greater resistance to denudation from their inward dip." (Whitaker, *Memoir*, pp. 355, 356.)

Elsewhere Mr. Whitaker has pointed out how Blackheath and similar shingly areas assert the tendency of the pebble-beds and gravel-deposits to form flats.

The gently rising hills of the London Clay are thus explained: "Formations which are of uniform structure throughout, and comparatively thick and wide-spreading, generally give rise to a more or less undulating country. The London Clay, though tenacious, is prone to slip, and cannot support a high angle of slope."—*Memoir*, p. 356.

The form of the ground around London has a distinctive and expressive physiognomy of its own, and a selection of such

emoranda as these would give to the geological student the clues
the landscape contours of the whole district. How much can be
one by approaching the study of geology on its picturesque sidei s
ell shown in that remarkable volume of Mr. Ruskin's Modern
ainters, entitled "The Mountain Glory," a work we were pleased
o see alluded to in Mr. Whitaker's "Memoir." It seems to us that
hose who seek to educate the eye by the observation of land con-
ours are possessing themselves of the great principles of geology
y the true inductive process. Why physical geography is not
aught in field classes in our great public schools as the natural
ntroduction to the study of geology is one of the mysteries of our
present system of education. What could be a better change from
ndoor school studies than the outdoor pleasures of tracing the history
f the local landscapes, as registered in the forms of the ground—the
leasures of marking the effect of the meteorological forces, and the
endency of each formation to weather into its own particular con-
our or level of hill, valley, or plain? Perhaps the beginning of a
etter state of things is being initiated by Prof. Ramsay's "Physical
eology and Geography of Great Britain," and by the construction
f geological models of limited districts on a large scale.

It only remains to be said that in this great work we have for the
irst time, in the double form of map and model, and on a grand scale,
complete representation of the superficial and solid geology of
ondon. The adoption of a horizontal scale of such magnitude as
ix inches to the mile, instead of the toy-like dimensions of so many
odels, cannot be too highly commended. It is not too much to say
hat among those geologists who are indebted for all their facts to
riginal observation in the field, Mr. Whitaker is the only one who
ould have undertaken such an enterprise. The Jermyn Street
useum now possesses a geological model of London which is
orthy of the subject and the Survey. Its educational value is
imply inestimable.—HENRY WALKER.

REPORTS AND PROCEEDINGS.

.—BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. FORTY-THIRD MEETING, BRADFORD, September 18th—24th, 1873. TITLES OF PAPERS Read OR SENT TO BE READ IN SECTION C. (GEOLOGY).

President—Professor JOHN PHILLIPS, M.A., D.C.L. (Oxon.), LL.D., Camb. and Dublin, F.R.S., F.G.S.

Inaugural Address by the President, Professor Phillips, F.R.S. Printed *in extenso* in October Number, GEOL. MAG., 1873, p. 473.)

large Geological Map of the British Isles was presented to the British Association by the Local Committee, and was exhibited in the room.

Russell, C.E., F.G.S., H.M. Geological Survey—Geology of the Country around Bradford.

ohn Brigg.—Geological Sketch of Bradford and the Neighbourhood.

ev. J. F. Blake, F.G.S.—Additional Remains of Pleistocene Mammals in Yorkshire.

J. R. Dakyns.—A Sketch of the Geology of part of Craven, comprising the Country about Keighley, Skipton, and Grassington.

H. B. Brady, F.L.S., F.G.S.—On *Archædiscus Karreri*, a New Type of Carboniferous Foraminifera.

W. Pengelly, F.R.S.—Ninth Report of the Committee for the Exploration of Kent's Cavern, Torquay.

W. Boyd Dawkins, F.R.S.—Report of the Settle Cave Committee.—Note on the rate of the increase of Stalagmite in the Ingleborough Cave.

Dr. Leith Adams, F.R.S.—Concluding Report on Maltese Fossil Elephants.

W. Boyd Dawkins, F.R.S.—The Relation of the Pleistocene Mammalia to the Glacial Period.

Rev. H. W. Crosskey, F.G.S.—Report of the Boulder Committee.

W. Gomersall.—The round Boulder-clay Hills of Craven.

W. T. Blanford, F.G.S.—On some Evidence of Glacial Action in Tropical India in Palæozoic, or the oldest Mesozoic times.

J. Thomson, F.G.S.—Report on the Investigation of Carboniferous Corals.

J. E. Taylor, F.G.S.—The Occurrence of Elephant Remains in the Basement-bed of the Suffolk Red Crag.

Professor Harkness, F.R.S.—On Faults in the Permian Sandstone in the lower portion of the Vale of the Eden, Cumberland.

Professor A. S. Herschel, F.R.A.S., and G. A. Lebour, F.G.S.—Notes on some Experiments on the Conducting Power for Heat of certain Rocks.

W. Topley, F.G.S., and G. A. Lebour, F.G.S.—On the Whin Sill of Northumberland.

T. Moffatt, M.D., F.G.S.—On Geological Systems and Endemic Diseases.

L. C. Miall.—Report on the Labyrinthodonts of the Coal-measures.—Part I.—On the General Structure of the Labyrinthodonta.

W. Horne.—On the Occurrence in the Yoredale Rocks of Wensleydale of Fish and Amphibian Remains.

H. Woodward, F.R.S.—Seventh Report on Fossil Crustacea (see p. 520).

H. Woodward, F.R.S. and R. Etheridge, jun., F.G.S.—On some New Species of Phyllopodous Crustacea belonging to the Genus *Dithyrocaris* from the Carboniferous Series, with Notes on others already described (see p. 482).

H. Woodward, F.R.S.—On some Intermediate Forms between Birds and Reptiles.

W. Jolly.—Second Report on the discovery of Fossils in certain remote parts of the North-Western Highlands.

H. Hicks, F.G S.—On the Arenig and Llandeilo Rocks of St. David's.

J. Hopkinson, F.G.S.—On some Graptolites from the Upper Arenig Rocks of Ramsey Island, St. David's (see p. 518).

J. Hopkinson, F.G S.—On the Occurrence of Numerous Species of Graptolites in the Ludlow Rocks of Shropshire (see p. 519).

J. Logan Lobley, F.G.S.—On the British Palæozoic *Arcadæ*.

Dr. Bryce, F.G.S.—Report on Earthquakes in Scotland.

Professor J. Tennant, F.G.S.—Notes on Diamonds in South Africa.

Baron Von Richthofen.—The Loess and Salt Basins in Northern China.

W. Whitaker, B.A., F.G.S.—Note on the Occurrence of Thanet Sand and Crag in the North-West Corner of Suffolk (Sudbury).

J. W. Ellis.—Note on Stump Cross Caverns, at Greenhow, near Pateley Bridge.

II.—"ON SOME GRAPTOLITES FROM THE UPPER ARENIG ROCKS OF RAMSEY ISLAND, ST. DAVID'S." BY JOHN HOPKINSON, F.G.S., F.R.M.S.

At the meeting of the British Association at Brighton last year the author gave an account of a number of Graptolites which had recently been found in the Arenig rocks of Ramsey Island and Whitesand Bay, near St. David's, and these beds were shown to be more nearly allied by their Graptolites (of which twenty-two species belonging to nine genera were enumerated) to the Quebec rocks of Canada than to their British representatives, the Skiddaw slates of Cumberland and the Arenig rocks of Shelve. The St. David's beds which had then been examined were also stated to be most probably of Lower Arenig age.[1]

Since then a new series of graptolite beds have been discovered on Ramsey Island, and the author had examined the graptolites collected. Owing to their fragmentary condition the following species only could be determined:—*Didymograptus affinis*, Nich.; *D. bifidus*, Hall; *D. geminus*, His. sp.; *D. patulus*, Hall (=*D. hirundo*, Salt.); *Diplograptus dentatus*, Brong. sp. (=*D. pristiniformis*, Hall); *D. mucronatus*, Hall; and *Climacograptus scalaris*, Linn. sp.

The evidence afforded by these species was considered to be decidedly in favour of the view that these new Ramsey Island beds are of Upper Arenig age, and therefore higher than those previously known.

Comparing the graptolites of the Skiddaw slates of Cumberland and the Arenig rocks of Shelve with those of the Lower and Upper Arenig rocks of Ramsey Island, there appeared, upon the whole, to be a parallel succession of species in the Shelve and St. David's rocks, the Dendroidea abounding in the lower beds in each area, and the slightly diverging species of *Didymograptus*, with species of *Diplograptus* and *Climacograptus*, being found in the upper beds only; while the Skiddaw series, in which no dendroid graptolites are known to occur, seemed to be more nearly related to the upper than to the lower Ramsey Island beds; and it was inferred that the Skiddaw slates, which have hitherto been considered our oldest graptolite-bearing rocks, are of more recent age than the lowest graptoliferous rocks of St. David's.

III.—"ON THE OCCURRENCE OF NUMEROUS SPECIES OF GRAPTOLITES IN THE LUDLOW ROCKS OF SHROPSHIRE. BY JOHN HOPKINSON, F.G.S., F.R.M.S.

Until recently only two species of Graptolites, *Monograptus* (*Graptolithus*) *priodon* and *M. colonus*, were believed to occur in the Ludlow rocks of Shropshire. In 1868 Dr. Nicholson added to these a new species of *Ptilograptus*, and mentioned the presence of an additional species of *Monograptus*. These had been collected by Mr. Lightbody of Ludlow, who had also found a few other species in these rocks.

In the course of an excursion of the Geologists' Association to the Silurian rocks of Shropshire, in July, 1872, and during a subsequent visit which the author had recently paid to Ludlow and its neighbourhood, several other species had been found, and some information on the distribution of the species had been elicited.

While, however, the number of species known to occur in the Ludlow rocks have been greatly augmented by these researches, one or two forms hitherto supposed to be characteristic of one or other division of these rocks had not been found in them. Not a single specimen of *Monograptus priodon* had been seen in the Ludlow rocks, all that had been found being from the Wenlock shale; and not a single graptolite had been detected in the Upper Ludlow rocks, although two species, *M. colonus* and *M. priodon*, had been stated to be of common occurrence in both the Lower and Upper Ludlow. The graptolites, with the exception of a species or two of the Dendroidea, appeared to have died out for ever in the Aymestry Limestone, in which a few indeterminable fragments only had been found.

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[1] See GEOL. MAG., Vol. IX., p. 467, and Trans. Liverpool Geol. Soc., session 1872–3.

Of the true graptolites, or Rhabdophora, but a single genus, *Monograptus*, occurs; and only one genus of the graptolite allies, *Ptilograptus*, is undoubtedly present. The species are as follows:

Monograptus Bohemicus, Barr.
——— *capula*, sp. nov.
——— *chimaera*, Barr.
——— *clavicula*, sp. nov.
——— *colonus*, Barr.
——— *iucurvus*, sp. nov.
——— *Leintwardensis*, sp. nov.
Monograptus Nilssoni, Barr.
——— *Salweyi*, sp. nov.
——— *serra*, sp. nov.
Ptilograptus Anglicus, Nich.
——— *elegans*, sp. nov.
———(*vel Dendrograptus*) *Nicholsoni*, sp. nov.

These species were found to be restricted in their range in time, and to characterize the same zones at distances wide apart. Some progress had been made towards working out this interesting question; but the author considered a more lengthened investigation of the Lower Ludlow rocks in the Ludlow area to be necessary before any definite conclusions could be arrived at.

IV.—SEVENTH REPORT OF THE COMMITTEE APPOINTED FOR THE PURPOSE OF CONTINUING RESEARCHES IN FOSSIL CRUSTACEA—CONSISTING OF PROF. P. MARTIN DUNCAN, M.B., LOND., F.R.S.: HENRY WOODWARD, F.R.S.; AND ROBERT ETHERIDGE, F.R.S.

Drawn up by HENRY WOODWARD, F.R.S.

LAST year, at the Brighton Meeting, I was enabled to lay before this Section a very considerable list of accessions to Fossil Crustacea, and also a goodly account of work performed. A very fruitful season is not unfrequently succeeded by a smaller harvest. Such is the case with my Report this year. I am, however, able to show some favourable results.

Part V. of my Monograph on the MEROSTOMATA, containing the Sub-Order XIPHOSURA, will be ready for publication before the end of the present year. I have included in it the following genera and species, namely :—

Bellinurus Königianus, H. Woodw.	Coal M.,	Dudley.
——— *bellulus*, König.	,,	Coalbrookdale.
——— *reginæ*, Baily.	,,	Queen's Co., Ireland.
——— *arcuatus*, Baily.	,,	,,
Prestwichia Birtwelli, sp. nov., H. Woodw.	,,	Lancashire.
——— *anthrax*, H. Woodw., 1866.	,,	Coalbrookdale.
——— *rotundata*, H. Woodw.	,,	,,
Neolimulus falcatus, H. Woodw.	U. Silurian,	Lanarkshire.

I have also introduced into this Part of my Monograph those singular forms which occur in the Carboniferous Limestone at Cork, in Ireland; at Settle and Bolland, in Yorkshire; and at Visé, Belgium; referred to the genus *Cyclus*, namely :—

Cyclus bilobatus, H. Woodw.	Carb. L., Ireland.
——— *torosus*, „	„ „
——— *Wrightii*, „	„ „
——— *Harknessi*, „	„ „
——— *radialis*, Phillips, sp.	„ Yorkshire, etc.
——— *Jonesianus*, H. Woodw.	„ Ireland.
——— *Rankini*, „	Coal Shales, Carluke.
——— (*Halicyne*) *laxus*, von Meyer.	Muschelkalk, Germany.
——— (*Halicyne*) *agnostus*, „	„ „

These last are doubtless either larval forms of other Crustacea, or else they belong to a peculiar group, whose appearance in time has been exceedingly limited. They remain for the present among the unsolved problems of the palæozoologist.

Whilst referring to the fossil *Limuli*, I would briefly allude to the valuable contributions to the anatomy of the living *Limulus*, or "King-Crab," of the North-east coast of North America—one by my distinguished chief and colleague, Prof. Owen (published in the Linnæan Transactions for this year);[1] the other by Prof. Alph. Milne-Edwards (in the Annales des Sciences Naturelles).[2]

Limulus polyphemus of North America, and the closely allied species common to the Moluccas and the coasts of China and Japan, is the sole existing type of this ancient race, whose longevity as an Order in time is unsurpassed among the Crustacea, save by the Entomostraca alone—*Neolimulus* of the Upper Silurian of Lanark closely agreeing with the larval stage of the living *Limulus*, called by Dohrn the "*Trilobiten-stadium*."

By the kindness of Prof. Owen, I am permitted to add three plates from his memoir on the modern American King-crab, to illustrate my Monograph on Fossil *Limuli*. I have also introduced (from Dr. Packard's and Dr. Dohrn's works) figures of the larval stages of *Limulus polyphemus*, and from that of Barrande, figures of the larval forms of certain Trilobites, the development of which he has traced often (as in the case of *Sao hirsuta*) through more than twenty stages.

Having read carefully the arguments of Dr. Dohrn, and subsequently the views of Dr. Packard, the elaborate papers on the anatomy of *Limulus* by Alphonse Milne-Edwards and Prof. Owen, I find nothing in these several memoirs to lead me to distrust or abandon the conclusion at which I had arrived in 1866 (see Brit. Assoc. Reports, Nottingham, and Quart. Journ. Geol. Soc., 1867, vol. xxiii. p. 28), as to the correctness of associating the EURYPTERIDA and XIPHOSURA under the Order MEROSTOMATA, but much to confirm and strengthen that conclusion.

Prof. Owen fully concurs with my general views of the MEROSTOMATA as an Order, although he differs from me in some minor points in reference to the structure of *Limulus*.

For example, he considers the anterior shield, as I do, to be the cephalon, merely proposing for it the name *cephaletron;*[3] whilst for the posterior shield (which I demonstrated in 1866 to be the conjoined thorax and abdomen) he gives the name *thoracetron;* and to the telson, or tail-spine, he applies Mr. Spence Bate's name of "pleon."

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[1] Trans. Lin. Soc., 1873, vol. xxviii. pt. iii. p. 459, plates xxxvi. to xxxix.

[2] Ann. des Sc. Nat. Zoologie et Paleontologie, 1872–3, 5th series, tome xvii. p. 25, plates v. to xvi.

[3] From κεφαλή, *the head*, and ἦτρον, *a part of the abdomen*, in allusion to the fact that (as in other Crustacea) "a part of such cavity is associated with the 'head' in

There can be no objection to the term "cephaletron," as proposed for the head in Crustacea by Prof. Owen, in contradistinction to that highly specialized division of the body, the "head" in the *Vertebrata*, but I think I have shown good grounds (in the paper referred to) for assuming that the posterior shield is not merely the thorax (or "thoracetron" of Owen), but the combined thoracic and abdominal segments, as attested by the larval or embryonal stages of *Limulus*, and by the fossil forms of the Coal-measures and of the Silurian.

I venture also to demur to Spence Bate's term "pleon" being restricted to the tail-spine in *Limulus*, because it is calculated, if so used, to cause considerable confusion. The term "pleon," as applied to the Crustacea by its author, includes the *last seven segments* of the body, of which the *telson* (if reckoned *at all* as being a segment) has hitherto only been accounted as the ultimate joint out of the series.

The view propounded by Prof. Owen (*op. cit.* p. 477) that the great caudal spine in *Limulus* represents (either by itself, or possibly with the hindmost segments of the 'thoracetron') the 'pleon' of Spence Bate (or in other words, the last seven, or abdominal segments usually seen in other Crustacea), is based on his examination of the innervation of the tail-spine. From its dissection he finds that the bifid continuation of the great neural axis is divided within the triangular tail-sheath (telson) into a double plexus of fine nerves resembling the *cauda equina* of anthropotomy. In this fasciculus of nerve threads the author traces nine nerve filaments, four ventral and four dorsal, the ninth being the continuation of the bifid neural axis. From this he concludes that the tail-spine may indicate as many as four coalesced segments, which, with the three posterior coalesced apodal segments of the 'thoracetron,' would account for the missing abdominal series or 'pleon.' But notwithstanding my profound respect and appreciation of Prof. Owen's comparative anatomical studies, and his conclusions thereon, I find great difficulty in adopting this view, because it appears to me that it does not accord with those generally entertained regarding similar structures in other orders of Crustacea, neither will it harmonize with the earliest known forms of the *Xiphosura*, nor with the larval development of recent *Limulus*, as made known by the researches of Packard[1] and Dohrn.[2]

Prof. Owen names the modified bifid median appendage behind the mouth of *Limulus* the "chilaria,"[3] this is, doubtless, the homologue of the great metastomial plate of *Pterygotus*.[4]

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the first division of the King-crab's body, and with the 'thorax' in the second division."—(Owen, *op. cit.* p. 463.)

[1] "The Development of *Limulus polyphemus*," by A. S. Packard, Jun., M.D. Mem. Boston Soc. Nat. Hist., 1872, vol. xi. pp. 155–202, pl. iii.–v.

[2] "Zur Embryologie und Morphologie des *Limulus polyphemus*, von Dr. Anton Dohrn," Jenaische Zeitschrift, Bd. vi. Heft 4, p. 580, Taf. xiv. and xv., 1871.

[3] From *χειλάριον*, a small lip (Owen, *op. cit.* p. 464).

[4] As pointed out by me, see Fifth Report on Fossil Crustacea, by H. Woodward,

[Dr. Packard, when contrasting (in his work on Larval *Limulus*) the MEROSTOMATA with TRILOBITA, by an inadvertence, calls the Metastome the "Hypostome," and contrasts it with the Hypostome in Trilobites, in which no lower lip exists.]

Referring to the habits of the Pterygoti, Prof. Owen considers they were those of burrowers, like the *Limuli;* but their bodies and broad swimming feet seem eminently fitted for natation. On the other hand, he thinks *Limulus* could not walk well, but only crawl and burrow. We have frequently seen them alive in the Aquaria at the Zoological Gardens, and they walked with very considerable ease and activity on the tips of their toes. They are, however, true burrowers by habit.

Prof. Owen is willing to accept the theory of the development of the Merostomata from a typical and common life-form, but by "secondary causes or laws," not by Natural Selection. (p. 501, *op. cit.*)

Several additions have been made to the Carboniferous Phyllopods, the species of which I have described in conjunction with my friend Mr. Robert Etheridge, junior (of the Geological Survey of Scotland). (Some notice of these is given more in detail in a separate paper, see page 482.)

Of Cretaceous forms I have examined several new species, among which are—Three examples of the carapace of a small Gault crustacean from Folkestone (near to *Diaulax Carteri* from the Cambridge Greensand), which I have named *D. feliceps.* Two small forms of *Scyllaridia* (a genus hitherto only known in the Eocene Tertiary)—*Scyllaridia Gardneri*, sp. nov., and *Scyllaridia punctata*, sp. nov. A small *Crangon* (?) of doubtful determination, with two delicately serrated lines on the anterior half of the carapace in front of the nuchal furrow, the hinder part armed with very minute spines, the surface of the carapace being ornamented with very minute and scattered serrations, the carapace, hands, and detached body segments of which are all of a glistening black enamel. I have named this *Mesocrangon atra.* These specimens are principally from the collection of J. Starkie Gardner, Esq., F.G.S., who has kindly placed them at my disposal, with others for examination.

Fifteen years ago Mr. Charles Gould, F.G.S., described[1] a very imperfectly preserved carapace of a small crustacean under the name of *Mithracites vectensis*, from the Greensand, Atherfield, Isle of Wight. I lately obtained six specimens from the same locality, which, upon comparison, I found to agree (so far as the figure and description enabled me to determine) with Gould's *Mithracites;* but when I compared the specimens with the recent *Mithrax*, I failed to discover the analogy, although the specimens since obtained appear to offer a decided affinity with *Hyas.* The discovery of these additional examples will necessitate the reconsideration and redescription of the genus *Mithracites.* Fortunately the abdomens of both male and

British Association Reports, Edinburgh, August, 1871, p. 53, and GEOL. MAG., 1871, Vol. VIII. pp. 521–524.

[1] See Quart. Journ. Geol. Soc., 1859, vol. xv. p. 237. See also Prof. Bell's Mon., part 2, Pal. Soc., 1862; Crustacea of the Gault and Greensand, p. 1, pl. 1, figs. 2 and 3.

female examples are preserved, the limbs and the margins of the carapace are also well seen.

From the Greensand, Isle of Wight, I have also obtained a new species of *Hemioön?* (Bell), but larger than *H. Cunningtoni.* From the Hard Chalk, Dover, I have received a new form of *Enoploctytia*, which I propose to call *E. scabrosa.*

Only one new species of Trilobite has to be noticed; it was found at Utah, and sent over by Mr. Henry S. Poole, Inspector of Mines, Nova Scotia. I have referred it to the genus *Olenus*, under the name of *Olenus Utahensis.* It shows evidence of a median axis apparently corresponding with the so-called "*straight alimentary canal*" noticed by Barrande. The matrix is composed of a hydrated silicate of magnesia.

This completes my list of new forms examined and determined by me. Some of them are already engraved for publication.

V.—Royal Cornwall Geological Society.—The annual meeting of the Royal Cornwall Geological Society was held on Friday, Oct. 17th, at the Museum, Penzance. Mr. Warington Smyth, F.R.S., the President, occupied the Chair; and there was a large company present.

The President opened his address by a feeling reference to the loss of Miss Carne, who, alike by her intellectual power, her generosity, and her cheerful industry, had for years past in the highest degree fostered and advanced the interests of the Institution. In her had been lost not only a munificent donor, but a kind friend, ever ready to volunteer counsel or aid by work of hand or head whenever her quiet judgment suggested that they would be welcome. That spacious apartment, where, without her aid, they would hardly have been able to meet that day, was, perhaps, not the place to refer to her noble and discriminating charities, and the numerous deeds of goodness upon which many a tongue in that neighbourhood would gladly dilate. But they could not neglect there to dwell upon the admirable work done in their own particular sphere, and on the useful example set by a life so wisely spent. Few of his auditors were unaware that when a large amount of debt appeared likely to interfere with that Society's enjoyment of the new buildings, she undertook on easy terms to arrange for the payment of £500 of it. Then they were deeply indebted to her and to her excellent and unwearied elder sister for the admirable arrangement of their collection. In her varied acquirements as an observer in Geology and Natural History, and in her facility as a writer, Miss Carne followed worthily in the footsteps of her father, one of the founders of the Society, and of her uncle, whose "Letters from the East" formed one of the best books of travel of the last generation. It was with regret, he confessed, that certain of Miss Carne's original observations communicated to the Society were not yet printed; and it might be hoped that this would lead to an effort to bring up the arrears of publication. After referring at some length to Miss Carne's last work—"The Realm of Truth"—the President proceeded to give a brief biographical sketch of Professor Sedgwick, who was one of the honorary members of the Society, referring specially to the labours of that great geologist in connexion with that county, together with Sir Roderick Murchison for the establishment of the Devonian system.

From the list of contributing members there had also been lost the name of Mr. J. T. H. Peter, of Chiverton. The death of Sir Edward St. Aubyn had robbed the Society of the representative of one of the oldest Cornish families, yet every member of the Society would feel the satisfaction of his place in the county being so worthily filled by his son.

Mr. Smyth then turned to general topics. In his address of the previous year he had directed attention to the important subject of the utilization of the Society's collection of fossils. The excellent report prepared by Mr. Bettany, jun., made it clear that a valuable series of collections had been accumulated chiefly by donations, but largely by special purchases, which, so long as they remained packed in boxes, or closely stowed away pell-mell in drawers, were practically useless. Until, indeed, they could on some definite plan of arrangement be exhibited, the Society was not acting up to what might be expected of its "name and fame." That reproach had now to some extent been removed by a commencement, and as it was notoriously *le premier pas qui coute*, they might hope that ere long a much fuller display would minister to the attractions of the fossil room. They had to thank Mr. Bettany, jun., for the gratuitous services rendered in arranging a characteristic series in two of the table cases, and might hope that he would be enabled to fulfil his promise with regard to the other two. The table cases, put in order, contained first—the groups of fossil organisms illustrative of the Lower and Upper Silurian divisions, the Devonian and the Mountain Limestone. These they should hope to see well supplemented by additional examples, which would serve as standards of comparison with those of the various Cornish fossiliferous localities which would be exhibited in the cases not yet arranged. A moderate representation of the Coal Measures was also given; and there was a great fullness of fossil forms of the Jurassic (the Oolite). Hence a little sketch of palæontology was placed before the eye, which, mere sketch as it was at present, nevertheless enabled the Society to fulfil its duty of aiding the student or general reader, whether among the members or the general public, who in yearly increasing numbers visited the collections.

But the great object of the Society was undoubtedly minerals. They were assembled in a district where tin-mining dated back beyond tradition; where smelting works poured their blue smoke into the air; almost within sight of mines (Wheal Fortune and Wheal Vor) where steam-engines were erected half a century before the time of Watt, and his improvements, and they could not but give expression to the anxiety with which the prospects of the mines must be regarded. There had been other periods of depression and alarm, which had been successfully overcome. A memorial of the "gentlemen adventurers" in tin and copper mines in the county, dated before 1730, prayed for redress of the grievance of the excessive cost of coal, caused by the heavy duty on seaborne coal, inasmuch as it amounted to full fifty per cent. upon the amount paid to the coal owner. Who could have imagined that more than a century after this injurious tax was remitted by Parliament the mines would, in common with the whole population, be subjected to a still harsher and more cruel tax, which, with no scarcity of the article to warrant it, was adding, not fifty, but a hundred per cent. to the ordinary price; and thereby threatening with absolute destruction a large proportion of the mines in which steam power was indispensable? The dearth of good discoveries of tin and copper having with few exceptions been the rule for the past twenty years, had doubtless tended much to check the spirit of adventure and exploration, without which mining must gradually languish. But what a blow to absurd, because ignorant, despondency, they read in the words of the memorial 140 years ago—in the statement that the county had been "so entirely tried that there was not the least reason to expect any new discovery." And yet since then Cornwall for more than a century had been at the head of the tin and copper production of the world; individual mines had been successfully worked, and entire new regions of lodes profitably opened. As for exhaustion of lode area, a glance at lode maps would show the vast number of mineral veins just known, but only slightly explored, besides which they might fairly premise that numbers more were at present unknown.

As to depth, no doubt increased depth of working was attended with increased expense, but they could point to lodes like those of Dolcoath and Tincroft as continuing downward with undiminished strength in the nethermost levels. And after all, the depth reached, whilst nothing to the eye of the speculative geologist, was far exceeded by that of several of the European mines. He had inspected several successive workings between 410 and 470 fathoms deep at the productive silver-lead mines of Prizibram, in Central Bohemia, now continuing to deepen after 121 years of persistent profits. Unfortunately, however, for the Western mining district of England, not only had natural difficulties to be encountered, but the coal question had to be met, and formidable rivals from various quarters introduced their easily won stream-tin to the markets where Cornish tin used to reign supreme. No sooner were they somewhat released from the pressure of the East Indies than New South Wales, Queensland, Victoria, and Peru united in joint commercial attack, and now, as they read in last week's *Mining Journal,* Van Dieman's Land boasted the discovery of tin ore in large quantities. Mr. Smyth quoted various reports on the Queensland discoveries, and proceeded to remark that all this was of course very disquieting. But although such reports rendered it quite certain that a very large proportion of tin or its ore would make its way to this country, they had to remember that many of the descriptions were indited by persons not practically conversant with tin-stream-ing or mining, and that there was sure to be exaggeration. Mr. Smyth quoted likewise a report on the tin-stream district of Tenasserim, which was not likely to increase its production in any material degree. After referring to the Laurium mines, the President concluded by remarking upon the issue of a fourth edition of Lyell's "Antiquity of Man," and to Mr. Borlase's "Nænia Cornubiæ," a work in which the metalithic element was so strong as almost to stamp it as a work of applied geology, whilst the scientific treatment of the details of the sepulchral relics of the county entitled the author to the thanks of all who were not blind to the interest of the early history of the British race.

CORRESPONDENCE.

THE "SUB-WEALDEN" EXPLORATION—IMPORTANT DISCOVERY.

Sir,—I am able to announce to you an important fact in relation to our great "Sub-wealden" exploration. The specimens from the lowest part of the boring are marine deposits; they contain shells; among these are distinct small *Lingulæ*, which are identical with examples of *Lingula ovalis* from our Kimmeridge Clay in Shotover Hill. Mr. Peyton, to whose care in examining the shale from the boring, I am indebted for the specimens which, with the consent of Mr. Willett, have been placed in my hands for scrutiny, and the result is quite certain. There are other shells, but not sufficiently exhibited in these specimens (*Ostrea*, *Avicula?* Spine of *Acrosalenia?*).

It appears, then, that we have touched the great upper clays of the Oolites, without encountering shore sands or shelly Oolites—no Portlandian rocks have appeared. It is the open sea-bed which we have reached, and may not find other than clay deposits for a considerable depth. There may be no Triassic limestones or sandstones; and we may come on Palæozoic rocks at no enormous depth, and with no unusual difficulty.

John Phillips.

Oxford, 26*th Sept.* 1873.

ON A NEW METHOD OF WRITING CRYSTALLOGRAPHIC FORMULÆ.

Sir,—In the September Number of this Magazine (p. 428), Mr. Danby does me the honour to criticize my paper on Crystallographic Formulæ (p. 299).

His objections to my proposed system of writing formulæ appear to me to be just; and with regard to the application of the system to the more advanced requirements of the crystallographer, they seem not merely just, but important, and it was from anticipation of such objections that I refrained from making any mention of Professor Miller's system. Upon one point, however, Mr. Danby appears to have put a wrong construction, namely, in crediting me with the presumptuous notion that my method of writing these formulæ should be able "to sweep all others from the field."

I intended my little paper merely as a suggestion, capable of modification and improvement, but, nevertheless—a suggestion which

I thought, and still think, would be of some use, if adopted, in elementary teaching. But, if this be all, Mr. Danby will then "pronounce the system unprofitable." Here I differ from him, for probably out of every hundred students who commence crystallography, not more than a tithe of them ever learn, or care to learn, more than the rudiments of the science. An elementary knowledge of the subject is usually deemed sufficient for ordinary purposes; and a sound elementary knowledge is by no means without its value. Is it, then, "unprofitable" if ninety per cent of students can, by any means, acquire more easily that which they wish to acquire? I may here cite the well-worn proverb that a steam-hammer may be used for cracking small nuts, but that the same end may be attained by simpler means. With regard to the higher branches of crystallography, Mr. Danby's estimate of my system may possibly be correct. Still, I do not think that the student who used it would have anything to unlearn. I thank Mr. Danby for taking the trouble to test the merits or demerits of the system, and I trust that others whose requirements are more purely elementary may be induced to give it a fair trial. FRANK RUTLEY.

H.M. GEOLOGICAL SURVEY.

GLACIATION OF THE LAKE-DISTRICT.

SIR,—I feel that some apology is due from me to Mr. Mackintosh, Dr. Bryce, and others, for not having alluded in my paper on "The Glaciation of the Northern Half of the Lake-district," to the work previously done by others on the same subject. My reason was this: The papers upon this subject are so numerous, and so generally—I do not say universally—the result of hasty runs through the country, that I felt it difficult to allude to some, and give no notice of others. It was my intention, moreover, when the subject should be treated more completely in a forthcoming Survey Memoir, to give a list of all papers bearing upon it. My official work has enabled me to go more minutely over the district than perhaps any previous worker, and I need hardly say that all conclusions arrived at in my recent paper were founded on self-observed facts. Since its reading and publication in the Journal, I have learnt that Dr. Bryce, in 1853 and following years, opposed the idea of a great ice-cap coming from the north-east, and completely riding over the Lake-district mountains, in papers communicated to the Philosophical Magazine, British Association, and Glasgow Philosophical Society.

KESWICK. J. CLIFTON WARD.

GEOLOGY OF THE LAKE-DISTRCT.

SIR,—May I be allowed through the medium of your MAGAZINE to ask authors of Papers on the Geology of the Lake-district to do me the favour of sending the titles of the same upon post-cards or otherwise?

GRETA BANK COTTAGE, KESWICK. J. CLIFTON WARD.

THE
GEOLOGICAL MAGAZINE.

No. CXIV.—DECEMBER, 1873.

ORIGINAL ARTICLES.

I.—Geologists' Association, University College, London. Address at the opening of the Session, November 7th, 1873.

By the President, Henry Woodward, F.R.S., F.G.S., etc.

TIME with slow and measured tread moving over the buried records of the past—Time, upon whose ample store the geologist is wont to draw with an unsparing hand, seems to have accelerated his pace in this nineteenth century, and hurries onward as if his few remaining sands were well-nigh run.

But the progress of Time is as constant and unvarying to-day as it was when life first dawned upon our infant planet; the apparent change is only the result of our attempting to measure our brief history by the standard of the infinite universe.

Yet finite as is our individual existence, we are privileged in forming part of a race,—not ancient, as measured by the geologic record,—but one which, by slow and protracted processes of intellectual development, has achieved the power to grasp the most hidden secrets of Nature; to investigate and comprehend its laws, to decipher its monuments, and to evolve our planet's history from the chaos of the past.

These grand results—infinite in import to our race—have nevertheless all been accomplished by finite means; each year our knowledge grows broader and higher, like some mighty Atoll in the Pacific, not by vast accessions, but by the accumulated labours of individuals, in which each one of us may have his part. Let us take a hasty survey of the geological aspect of our intellectual Atoll, and see how far we have added to our store of sound scientific knowledge during the past twelve months, and where there is still room for more work to be accomplished.

Our survey naturally divides itself under two main heads, namely: —I. Geology (properly so called); and II. Palæontology.

I.—By Geology we comprehend a study of the earth's crust, its composition and arrangement, which naturally is divided again into: —(*a.*) *Petrology*; and (*b.*) *Physical Geology.*

(*a.*) For the first the geologist, says Forbes, needs the assistance both "of chemistry and the microscope; by chemical analysis he learns the percentage composition of the rock in question, and the microscopic examination informs him how the chemical elements are

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I.—GEOLOGY.

a. *Petrology.*—No class of rocks offers such varied and marvellous attraction for the speculative and theoretical geologist as do those remarkable bodies called "meteorites." Many of these have come to us as entire asteroids from Stellar space, through which—small as they are—they held their independent courses; and only succumbed (as our own planet may in its turn be obliged some day to do) to the superior attraction of a larger orb than its own.

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* "The Microscope in Geology," by David Forbes, F.R.S. Popular Science Review, [illegible]

The majority, it would seem, however, probably from unequal expansion and friction, caused by contact with our earth's atmosphere, not only become enormously heated, so as to fuse the exterior into a vitreous glaze, but not uncommonly burst into many fragments before reaching the ground.

These bodies have been found in nearly every quarter of the earth's surface: and as they are known to fall *at all times*, over land and over sea, their actual number in each year must in reality be very considerable.

Some are only of the size of dust or small gravel; others, like the Cranbourne meteorite, weighing 4½ tons; or that discovered in Siberia by the naturalist Pallas, in 1777, weighing 1500 lbs.; or the one at Bahia in Brazil, weighing nearly 7 tons; another at Chaco, also in South America, estimated at 13 tons; and the largest of all known meteorites, brought from Ovifak in Greenland by the Swedish Arctic Expedition, about 22 tons in weight.

The mineral species which have been found in meteorites are about twenty-six in number, viz.:—Sulphur; Carbon (amorphous and graphitic) and a crystallizable Hydro-carbon; Osbornite; Enstatite; Bronzite; Augite; Olivine; Anorthite; Labradorite?; Asmanite; Chromite; Magnetite; Cassiterite; Titanoferrite?; Troilite; Pyrrhotine; Oldhamite; Schreibersite; Metallic Iron containing Carbon, called Campbellite and Calypite (by Meunier), and the alloys of Iron with Nickel, to which the names Tænite, Kamacite, Plessite, and Octibbehite have been given.

A review of the chemistry of meteorites teaches us that they yield only those elements which we know to exist on our earth, and as they have not afforded us a single new element, we may justly conclude that the most distant regions in stellar space contain only a repetition, in varying proportions and combinations, of the same elementary substances.

This discovery of the Continuity of Matter throughout the Universe may justly be looked upon as among the greatest results of intellectual effort, and one of the grandest generalizations of modern science.

"Of these elements (in all sixty-four), nineteen have been proved to occur in meteorites, which consist of six non-metallic bodies: Silicon, Carbon, Sulphur, Phosphorus, Oxygen, and Hydrogen; five metals of the alkalies and earths—Potassium, Sodium, Calcium, Magnesium, and Aluminium; and eight other metals—Iron, Nickel, Cobalt, Manganese, Chromium, Copper, Tin, and Titanium.

"Traces of seven more have been reported, but may be regarded as doubtful, viz. Chlorine, Antimony, Arsenic, Lead, Glucinium, Yttrium, and Zirconium. An idea of the general per-centage composition of aerolites will be best obtained by a glance at the figures

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[illegible] be found for the analysis of the silicates [illegible]

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obtained in a pure state, by which the entire constituents could be determined in a single portion. The silica was removed by distillation with hydrofluoric acid, and afterwards estimated as fluosilicate of potassium.

The Busti Aerolite, which fell on 2nd December, 1852, near Goruckpur in India, was first examined, and found to consist of the following minerals:—*Oldhamite*, or monosulphide of calcium, which occurs in chestnut-brown nodules with cubic cleavage. This mineral is not only unknown in terrestrial strata, but has been for the first time met with in this meteorite. A body of such unstable characters points to peculiar conditions (as suggested already, by the occurrence of hydrogen in meteoric iron), under which meteoric minerals must have been formed. *Osbornite* is another new mineral, occurring principally in the *Oldhamite* of this stone in minute gold-coloured regular octahedra, but so very sparsely that determination of its constitution was almost impossible. They withstand the action of most reagents, and appear to be a compound of zirconium (or titanium) and calcium with sulphur and oxygen. *Augite*, in intimate association with Oldhamite, crystallizing in the oblique system, and exhibiting a remarkable dichroism of a pale violet-grey colour, and with the composition $(\frac{5}{8} Mg \frac{3}{8} Ca) Si O_3$. *Enstatite* in three varieties: a dark-grey tabular, a transparent white, and a semi-transparent grey, the crystallographic features of which were not well developed. They had but a slight difference in composition, and bear the greatest resemblance to the mineral found by Dr. Lawrence Smith in the Bishopsville stone. Nickeliferous iron, *Troilite* and *Chromite* in regular octahedra, are also present, but in very small amount.

The Manegaum Meteorite, which fell on the 29th June, 1843, at Manegaum in Khandeish, was found to consist of a single pale yellow-green silicate, the crystals and the fine ground-mass, in which they are inclosed, having the same composition: that of an *Enstatite* with the formula $(\frac{2}{3} Mg \frac{1}{3} Fe) Si O_3$. A very small amount of iron was also met with. This stone differed from that of Busti, in that the latter contains a nearly pure magnesian Enstatite, that of Manegaum being a highly ferriferous one. The two meteorites concur in throwing light on the nature of the flocculent opaque mineral seen in the microscopic sections of many meteorites.

The Breitenbach Meteorite was found at Breitenbach, in Bohemia, in 1861. It belongs to that class of meteorites which have been termed "siderolites," a sponge-like skeleton of nickeliferous iron inclosing silicates. The siliceous minerals in the present instance are two in number: the one is a ferruginous enstatite or bronzite, crystallizing in the rhombic system, and having the formula $(Mg \frac{4}{5} Fe \frac{1}{5}) Si O_3$; the other is a new form of silica, having the specific gravity of fused quartz (2·24), and crystallizing in the orthorhombic system, differing therefore in its system from the recently discovered tridymite of Vom Rath. *Asmanite*, as the meteoric silica has been named, constitutes almost one-third of the mass of mixed siliceous minerals. *Troilite* and *Chromite* are also sparingly met with. The iron has the composition Fe_{10} Ni, and contains a trace of copper. It is remarkable that this meteorite greatly resembles those of Rittersgrün and Steinbach, and it appears highly probable that they belong to the same meteoric fall which is believed by the illustrious Breithaupt (whose loss we have now to deplore) to have been the "Eisen regen," that occurred at Whitsuntide, 1164, in Saxony, when a mass of iron fell in the town of Meissen.

Several hundred meteorites have also been cut, under the direction of Prof. Maskelyne, and thin slices mounted for microscopic examination of their crystalline structure, a study which promises most valuable results for Petrology.

We have only space here to call attention in passing to a most important paper by the eminent French chemist and physicist, Prof. Daubrée, on Meteorites and their composition, given nearly *in extenso* in the GEOL. MAG. 1866, Vol. III. p. 362 and p. 414, and a later notice on the Classification of Meteorites (GEOL. MAG. 1868, Vol. V. p. 75), both of which are deserving of careful perusal.

Foremost among petrologists in this country must be mentioned the names of Mr. David Forbes, F.R.S., and Mr. Henry C. Sorby, F.R.S., some of whose researches have already been made public in the Transactions of the Royal Society and elsewhere.

Mr. Samuel Allport, F.G.S., Prof. Haughton, F.R.S., and more recently still Prof. Edward Hull, F.R.S. (Director of the Geological Survey of Ireland), have been devoting much care and attention to the microscopic investigation of igneous rocks and their constituent minerals. The most recent of these relate to the investigation of the Pitchstones and Felsites of Arran by Mr. Allport:[1] and that of the Limerick Traprocks and Irish Granites by Prof. Hull.[2]

An important step has been taken by the former writer towards the demolition of that long-prevalent and once generally-received doctrine that the eruptive rocks of Palæozoic age were always distinct in composition and structure from those of the Tertiary period. Mr. Allport points out that great differences do certainly exist between augitic lavas of different volcanic districts; but he maintains that the same is true of those of the older geological periods, and similar differences occur between rocks of various ages.

"Thus, by ignoring the distinction now made between rocks of different ages, when there is really no essential difference between them, we should get rid of *melaphyr, aphanite, anamesite, diabase*, and *greenstone*. The three former are but varieties of 'dolerite,' 'diabase' is simply an altered 'dolerite,' while 'greenstone' has now no definite meaning whatever, having been applied to diorites, dolerites, felsites, or in fact to any rock which a collector or writer could not make out."[1]

(*b.*) *Physical Geology* (Mountains).—In traversing the surface of our earth, or in crossing the waters of the ocean, we meet with forms of beauty, grace and grandeur which impress themselves in varying degrees of intensity upon our senses. But there is none perhaps calculated to produce a more vivid and durable impression on the mind than the contemplation of a lofty mountain, especially when viewed from a level plain or from the sea. With the exception of volcanic cones, there are however but very few solitary mountains which rise by themselves in the midst of a level country.

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[1] S. Allport, "Igneous Rocks of Arran," GEOL. MAG. 1872, Vol. IX. p. 544. See also op. cit. 1873, Vol. X. p. 196.

[2] Prof. Hull, GEOL. MAG. 1873, Vol. X. pp. 153 and 193.

In almost all the countries of the world—in those at least which possess any at all strongly-defined relief—we meet with summits in considerable numbers, either arranged in groups or in long ranges. As an illustration of the former we may give the Hartz Mountains in Germany; Mount Sinai in the Arabian Peninsula; and the lofty cluster of the Sierra-Nevada of Santa Marta rising to 19,680 feet.

The chains, properly so called, which are always distinguished by a considerable development of the length of the upheaved ground, sometimes also have a dominant peak as their central culmination on each side of which the summits of the ridge become gradually lower. One of the finest illustrations of a mountain-chain is that of the South American Andes; their extreme regularity of form and the harmony of their arrangement through the enormous length of 4350 miles, together with the great height which its peaks maintain over a space of about 50 degrees of longitude, give to this chain a unique and typical character.[1]

In past ages every mountain-peak of importance and prominence was worshipped or venerated as the seat of some divinity. Although this particular form of idolatry is not pursued in the nineteenth century (save by the members of the Alpine Club, who make still their annual human sacrifice upon the summits of the Matterhorn or Monte Rosa), to the geologist of to-day the mountains afford peculiar attraction. For to him they are illustrations of accumulation and elevation upon the grandest possible scale, extending over the largest area of surface, and occupying the longest period of time in their formation of any feature of the earth's crust with which he is brought in contact. To a certain extent they govern the form of continents: for their direction or axis being that of the elevating force, must correspond in a general way with that of the land around them and at their feet. They are also among the most permanent features of the earth's surface, and the most difficult to obliterate.[2]

The question of the formation of mountain-chains has of late occupied the consideration of many of our ablest and most profound physical geologists. Names like those of Poulett-Scrope,[3] Dana,[4]

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[1] Reclus' "The Earth," English Edition, section i. chap. xix.

[2] Ansted's Physical Geography, p. 74.

[3] See "Observations on the Internal Fluidity of the Earth," by G. Poulett-Scrope, F.R.S., GEOL. MAG. 1868, Vol. V. p. 537, and Vol. VI. p. 145. "Cause of Volcanic Action," GEOL. MAG. 1869, Vol. VI. p. 196. Prefatory Remarks to the *Reissue* of Mr. Poulett-Scrope's great work on Volcanos, 1872, London, 8vo., Longmans, pp. 490, illustrated by plate and map and about seventy woodcuts, with a Second Appendix of Earthquakes and Volcanic Eruptions from 1860-72.

[4] See Prof. Dana's papers in Dana's and Silliman's American Journal of Science, 1873, vol. v. no. 29, p. 347, no. 30, p. 423; vol. vi. no. 31, p. 6, no. 32, p. 104, no. 33, p. 161. Prof. Dana's views were originally published in 1847.

Mallet,[1] James Hall,[2] Sterry Hunt,[3] Prof. Shaler,[4] Rev. O. Fisher,[5] Prof. J. D. Whitney,[6] Prof. Le Conte,[7] Medlicott,[8] Hutton,[9] and many others, might be enumerated, to show how large a share of attention has of late been directed to its elucidation.

It would be quite impossible to give the views of all these writers in detail, but it may be practicable to point out some of the more important of the conclusions at which they have arrived.

And first it may be well to premise that it appears to have been very generally assumed among geologists that all the phenomena of corrugation of the earth's surface, whether exhibited in mountain ranges or in continents, are to be regarded as effects of one and the same cause, differing only in magnitude.

It is manifest that it is a matter of first importance, in seeking an explanation of the origin of these phenomena, to determine whether this assumed identity of cause be true or no. If it be a fact that continental elevations and mountain elevations are but degrees of effect of the same cause, then there should be no other differences in the phenomena than those of magnitude, or of features dependent directly upon the magnitude of areas involved in the disturbance; furthermore, there should be something like a series, at one extremity of which could be placed the greatest relief of continental fold and oceanic depression, and passing gradually to the most inconsiderable flexures. It requires no very careful examination to bring the observer to the conviction that these essential features do not exist. The phenomena observable in the two actions are not cognate.[10]

Whether we regard the earth as an oblate spheroid, perfectly solid throughout, or as having a more or less thick crust and a fluid interior, we are justified in considering it as suffering from cooling by radiation, and contracting in a more or less degree from a time *long antecedent* to the formation of the very oldest metamorphic or sedimentary deposits with which we are acquainted.

If the material of the globe were homogeneous, and therefore of equal conductivity along every radius, then the cooling and the consequent contraction along each radius would be equal, and, so far as this cause is concerned, the earth, though becoming smaller, would maintain its symmetry of form and its universal ocean. But such homogeneity could not be expected, nor does it exist. In a heterogeneous earth thus cooling, *areas of greater conductivity would* cool more rapidly, and therefore *contract more rapidly* in a radial direction. These more conductive areas with shorter radii would form the sea-bottoms, while the less conductive and therefore less radially contracted portions would become land-surfaces. The accumulation of water on the shorter or more contracted radii would not check the process; for although water is a bad conductor, yet it conveys heat from the bottom to the surface by *convection* with great rapidity: and therefore the process of cooling through a stratum of water would go on far more rapidly than through a stratum of any rocky material. The same process continuing would tend constantly to increase the inequalities thus commenced. In other words, the sea-bottoms would sink, and the continents increase in size and height. (Joseph Le Conte.)

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[1] "The Eruption of Vesuvius in 1872," by Prof. Palmieri, with Notes and Introductory Sketch of Terrestrial Vulcanicity, by Robert Mallet, F.R.S. London, Asher & Co., 1873.

[2] Hall's Palæontology of New York. See abstract of Prof. Hall's views by Prof. Dana, Silliman's Journal of Science. 1873, vol. v. no. 29, p. 347.

[3] Prof. T. Sterry Hunt, on "The Origin of Continents." Geol. Mag. 1867, Vol. IV. p. 223. "Chemistry of the Primeval Earth," *ibid.* 1867, Vol. IV. pp. 357 and 477. "On the Probable Seat of Volcanic Action," Geol. Mag. 1869, Vol. VI. p. 245; *ibid.* 1870, Vol. VII. p. 60.

[4] Prof. Shaler, "Formation of Mountain Chains," Geol. Mag. 1868, Vol. V. p. 511.

[5] Rev. O. Fisher, "On the Elevation of Mountain Chains," Geol. Mag. 1868, Vol. V. p. 493, and 1873, Vol. X. p. 248.

[6] Prof. J. D. Whitney, "On Mountain Building," p. 101.

[7] Prof. Le Conte in Silliman's American Journal of Science, 1872, vol. iv. no. 23, p. 345, and no. 24, p. 460.

[8] H. B. Medlicott, "On the Alps and Himalayas," Quart. Journ. Geol. Soc. 1868, vol. xxiv. p. 34.

[9] Captain F. W. Hutton, "On the Formation of Mountains," Geol. Mag. 1873, Vol. X. p. 166.

[10] Prof. Shaler, Geol. Mag. 1868, Vol. V. p. 514.

Thus, through the unequal contraction of the earth's crust, by which the great continental areas were originally elevated as vast anticlinals above the general ocean, the first preliminary stage necessary for the commencement of mountain-formation would be accomplished.

From this date sedimentary deposits on the largest possible scale, resulting from meteoric action over the newly-made continents, would begin to accumulate in the great submarine synclinals parallel to the coasts.

It is a well-known fact, first brought prominently forward by Prof. James Hall, that mountain-chains are composed of enormous masses of sediments 10,000, 20,000, or even 40,000 feet in thickness. How have these vast masses—accumulated at such low levels—been elevated, not merely on a line with the continent itself, but thousands of feet above the sea? And why does the yielding to horizontal pressure take place along these lines of deposit in preference to any other?

Prof. Joseph le Conte suggests that the answer is to be found in the theory of the aqueo-igneous fusion of deeply-buried sediments.

The accumulation of sediment, as first shown by Scrope, Babbage, and afterwards by Sir John Herschel, necessarily produces a rise of the geo-isotherms, and an invasion of the sediments by the interior heat of the earth. From this cause alone, taking the increase of interior heat at 1° for every 58 feet, or about 90° per mile, and adding the mean surface temperature (60°), the lower portion of 10,000 feet of sediments must be at a temperature of about 230°; and of sediments 40,000 feet thick, like those of the Appalachian chain, must be nearly 800° Fahr. Even the former moderate temperature, long continued in the presence of the included water of the sediments, would be sufficient to produce incipient change—at least segregation, if not metamorphism. In fact, segregation of sediments will probably take place under heavy pressure, even at ordinary temperature, but is no doubt hastened by high temperature. Such a temperature as 800° is certainly sufficient to produce not only metamorphism, but aqueo-igneous pastiness, or even complete aqueo-igneous fusion. With a small quantity of alkali in the included water of such sediments, all these changes would take place at a much lower temperature.

Suppose then sediments accumulating along the shores of a continent: the first effect is segregation, and therefore increasing density, and consequent contraction and subsidence *pari passu* with the deposit. Next, if the accumulation of sediment continue, follows aqueo-igneous softening, or even melting, not only of the lower portion of the sediments themselves, but of the underlying strata upon which they are deposited. The subsidence probably continues during this process. Finally this softening determines a line of yielding to horizontal pressure, and a consequent up-swelling of the line into a chain. Thus are accounted for, first the subsidence, then the subsequent upheaval, and also the metamorphism of the lower strata so universal in great mountain-chains. By this view, of course, the exposure of the metamorphic rocks on the surface is the result of subsequent erosion. Even the granitic axis, Le Conte thinks, in most cases is but the lowermost, and therefore the most changed portion of the squeezed mass, exposed by subsequent erosion; although it is by no means impossible that in some cases the granite may be squeezed out as a pasty mass through a rupture at the top of the swelling mass of strata.

This theory, as will be observed, strongly inclines towards the metamorphic origin of granite, but does not require it. For there is nothing to hinder the aqueo-igneous fusion of an original granite crust by the accumulations of sediments upon it, and the consequent yielding of the crust along the line of accumulation.

But a mountain-chain is *not* a simple mass of strata, which, becoming to a certain extent plastic, from aqueo-igneous action, and yielding to horizontal pressure, bends upwards into an arch, leaving a hollow space beneath, nor is it such an arch filled and supported by an interior liquid mass. On the contrary, if we examine carefully the structure of any extensive mountain range, we shall find that it is not only made up of masses of immensely-thick sediments, but that these have been folded, crumpled, crushed, fissured, and faulted in the most marvellous manner, whilst the intimate structure of the rock has been entirely altered by having undergone *slaty-cleavage*, produced by powerful pressure perpendicular to the planes of cleavage, by which the whole rock-mass has been mashed together and shortened in that direction, and correspondingly extended in the direction of the planes of cleavage. As these planes of cleavage are usually highly inclined, or *even vertical*, it is evident that the rock-mass has been crushed together horizontally, and swelled up, vertically. As a necessary consequence of the crushing together, we find associated with cleavage the most complex foldings, not only of *the strata*, but of the layers, and even of the finest lines of laminon. Taking an ideal cube of the original unsqueezed mass, the rrage ratio (according to the observations of Sorby and Haughton) the greatest diameter (*i.e.* in the plane of cleavage) to the least meter (or at right-angles to the cleavage) becomes, *after squeezing,* six to one. Suppose then a mass of sediments 10,000 feet thick jected to horizontal pressure and crushing sufficient to develope ll-marked cleavage-structure: a breadth of 2½ miles would be shed into one mile, and 10,000 feet thickness would be swelled to 000 feet, making an actual elevation of the surface of 15,000 feet. Thus "the phenomena of plication and of slaty cleavage demon-te a crushing together horizontally, and an upswelling of the whole ss of sediments; slaty cleavage proves, in addition, that the up-elling produced by this cause alone is sufficient to account for the ration of the greatest mountain-chains in the world."

Le Conte's essay has not only added many original and well-ected ideas upon this important subject, but it also embraces the lier observations of Scrope, Herschel, Dana, Sedgwick, Lyell, rry Hunt, Studer, Hall, etc. His article deserves the careful con-eration of geologists.[1]

But there is another phenomenon presented by mountain-ranges ich it is necessary to account for,—namely, the evidence which ny of them present of repeated oscillations of elevation and ression going on for immense periods of time, and extending over as of many thousands of square miles.

Such earth-movements which cannot be referred to the secular ling and contraction of the outer belt must be, says Mr. Poulett-rope, attributed to the irregular transmission of heat by conduction m one part of the subterranean matter to another, its isothermal nes, and consequently its expansion and contraction, varying with changes in the conductivity of the overlying rocks.

Before I leave this subject, I think it may be well to suggest a tion as regards the reception of one proposition which has been st ably advocated, both in this country[2] and also in America,[3] in erence to areas of deposition. It is that the "slowly progressing sidence over areas of accumulation *was occasioned by the weight* the slowly and successively accumulated sediments." There must a fundamental error in this proposition; for if 500 feet thickness moist sediment have power by gravitation to depress the sub-ent crust of the ocean-bed, how much more must the compact and id mass of the Himalayas—covering a length of 1550 miles and a adth of 620 miles, with its 380 peaks upwards of 20,000 feet ve the sea and two *nearly* 30,000 feet high—sink down into the lding crust beneath!

In a paper on "Volcanos,"[4] communicated by me to this Society,

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[1] See Dana's and Silliman's American Journal of Science, 1872, vol. iv. no. 23, 345. no. 24, p. 460; 1873, vol. v. no. 30, p. 448.

[2] "On Subsidence the Effect of Accumulation," by Dr. Charles Ricketts, F.G.S. OL. MAG. 1872, Vol. IX. p. 119.

[3] Prof. James Hall, Palæontology of New York.

[4] "On Volcanos," by H. Woodward, Proc. Geol. Assoc. 1871, vol. ii. p. 6, fig. 1; GEOL. MAG. 1871, Vol. VIII. p. 338.

I endeavoured to express, by a diagram, to how merely superficial a film of the earth's surface our knowledge is after all confined.

Such trivial modifications of elevation or depression as we see are, after all, only skin-deep; they are but wrinkles left by the hand of Time on the still fair face of Mother Earth.

Passing from the formation of mountain-chains to the meteoric agencies which have shaped them, and given to one and all the outward forms they wear to-day, we cannot but express our thanks to the Duke of Argyll for the very clear and able manner in which he has endeavoured to direct the current of geological ideas concerning that much-debated subject, Glacial action[1]—one of *the most potent agents* with which the geologist is acquainted, and which has undoubtedly played a most important part throughout our Northern Hemisphere in Pliocene and Quaternary times. When however ardent geologists invoke its aid, in the form of a great polar ice-cap, capacious enough to enwrap "e'en the great globe itself," alike forgetful of the fatal consequences to its Fauna and its Flora, I feel obliged as a palæontologist to protest against such severity.

Yet so strong is the faith in this universal *panacea* of ice, that Prof. Agassiz, when travelling in Brazil—*almost beneath the equator*—actually saw, in imagination, a mighty glacier upwards of 4000 miles in length, filling the vast valley of the Amazons, and stretching from its source in the Andes to Para, pushing its mighty terminal moraine before it to the sea. Then the glacier was melted, and became a huge lake with block-laden icebergs on its surface. Then the terminal moraine became weakened, and at last burst, and the vast flood of waters rushed seawards, leaving many a wreck behind!

This view of the glacial origin of the valley of the Amazons, writes Mr. C. F. Hartt, appears, from subsequent examination, to have been purely hypothetical, and the geological reading of the beds wholly erroneous.[2]

Prof. Phillips, in his "Geology of Oxford and the Valley of the Thames," and subsequently Mr. Henry Walker, F.G.S., have shown how the erratics of Cumberland, of the Midlands, or of Wales, may have been ice-borne and deposited upon the then submerged surface of the London area; and in company with Mr. Walker we have examined and endeavoured to learn the reading of the Glacial Drift at Finchley, the full account of which he promises to give us in his forthcoming work.

The valuable paper by Prof. Nordenskiöld on Greenland[3] has contributed much information as regards ice-formation and ice-action of immense value to geologists, and well calculated to have a modifying and corrective influence over our discussions of glacial theories.

Apart from astronomical causes, which must undoubtedly be invoked in order to bring glacial conditions down to such low latitudes as England and the South of France, we have in history

[1] See the Duke of Argyll's Address as President of the Geol. Soc., Lond., Quart. Journ. Geol. Soc. 1873, vol. xxix. p. xxx. and p. 508.

[2] See Silliman's American Journal, No. 19, for July, 1872, article by Ch. F. Hartt. p. 53.

[3] See GEOL. MAG. 1872, Vol. IX. pp. 289, 355, 409, 449, 516.

an excellent illustration of what a period of less than a thousand years can effect as regards climatal conditions by a very slight deflection in an oceanic current.

In 983 some Norwegian adventurers from Iceland discovered the continent of Greenland. They planted a colony on the eastern coast, and the intercourse between this colony, Iceland, and Denmark, was continued till the beginning of the fifteenth century.

From this date, owing to an insetting of the Arctic current and a consequent gradual increase of the Arctic ice upon the coast, the colony became inaccessible, and the records of it disappear from history. In 1579, 1588, 1605, 1607, 1652, 1670, 1671, 1751, and so on, down to our own time, the intrepid Danes have striven to reopen communication with their lost eastern colony, but all in vain, the pitiless "ice-pack" has shut in this emerald coast, whose valleys, well stocked with reindeer and covered with soft verdure, first attracted the desire of these hardy Norsemen to make it their home. It would be interesting to ascertain whether the increasing cold has fostered the growth of glaciers to such an extent as to fill the eastern valleys down to the sea-margin, or whether the little Danish colony has held its own, secluded from the outer world, and has maintained its primitive existence in this ice-bound land, occupying, as the western Greenlanders do, the sea-shore and the tract of low valleys bordering on the coast, which may have remained clear of ice, and which yield in the short hot arctic summer a fair amount of vegetation.

Turning our attention for a moment to the Rocky Mountains of North America, it is of great interest to the geologist to learn that evidences of the declining energies of two great forces—volcanic and glacial action—have been met with in this range.

The first is attested in the wonderful series of geysers, mud-volcanos, and thermal springs discovered and described by Dr. F. V. Hayden, U.S. Geologist, in Wyoming Territory;[1] the second by the discovery of still active glaciers in the Yosemite Valley and vicinity, in California, described by Prof. J. Le Conte and Mr. John Muir.[2]

Did space permit, I would allude to the labours of the American Geological Surveyors; to those of the Geological Survey of India; of our home Survey; and of that still more wonderful sub-marine Survey, begun in H. M. S.-Ships "Porcupine" and "Lightning" during 1868, '69, '70; and now being systematically carried on by the Admiralty in H. M. S.-S. "Challenger" by Prof. Wyville Thomson and his staff. But I find my time, and I fear your patience, will alike be exhausted ere I conclude.

I would fain bear testimony to the valuable work which has been carried on by members of this Association in the Menevian Rocks of St. David's. This task, initiated by Mr. Henry Hicks, F.G.S.,[3] and afterwards jointly carried on by Messrs. Salter and Hicks, has since been admirably worked out by Mr. Hicks alone (as regards the geology and palæontology), save in the matter of the *Graptolites*; these having been carefully investigated by Mr. John Hopkinson, F.G.S., and also studied by Prof. James Hall, of Albany, U.S.A., when visiting England last year, and tend to throw important light on the age of these beds.

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[1] See Dana and Silliman's American Journal of Science, 1872, third series, vol. iii. p. 161, and p. 295.

[2] See Dana and Silliman's American Journal of Science, 1873, vol. v. p. 69, and p. 325.

[3] Researches in the Lingula Flags of South Wales (Joint Report to British Association, Birmingham, 1865), GEOL. MAG. 1866, Vol. III. p. 27. On *Lingulella* from the Lower Cambrian, Quart. Journ. Geol. Soc. 1867, vol. xxiii. p. 339. On

Our esteemed Vice-President, Prof. Morris, has given us another valuable aid to our knowledge of the older Palæozoic rocks in the concise and clear summary he has furnished to Salter's Catalogue of the Palæozoic Fossils in the Woodwardian Museum at Cambridge. In that table we are supplied with a Concordance to the classifications of Sedgwick, Murchison, Jukes, Lyell, Phillips, and the Geological Survey; and thus one of the great stumbling-blocks to students is removed by his sure and experienced hand. It is confidently to be hoped that Sedgwick's classification (though late in receiving its just award) may now commence to be recognized and taught, and this is the more likely from the able manner in which Prof. T. Sterry Hunt has argued the case between Murchison's Silurian and Sedgwick's Cambrian claims.[1]

II.—PALÆONTOLOGY.

(*a*.) *Palæophytology*.—Much important work has been done in Fossil Botany during the past year by Williamson, Heer, Carruthers, Binney, Thiselton Dyer, and others, a record of which has annually been drawn up by Mr. Carruthers, and published in the GEOLOGICAL MAGAZINE (see October Number, p. 461).

In a subject like palæophytology, much time must necessarily be taken up in re-investigating doubtful points; for even where plant-remains are abundant, it is most often the case that the organs of fructification, upon which a really reliable determination might be based, are entirely absent, and, as pointed out by Bentham, Carruthers, and Wilson Saunders, orders of plants, totally diverse in character and distribution, have often *identically shaped foliage*, and it is upon fossil leaves most generally at least in the Neozoic formations that the botanist has to base his determination.

And here it may be desirable to explain how, notwithstanding this apparent insuperable difficulty, Professor Oswald Heer and other botanists have succeeded in their determination of Miocene and other plant-remains in so a remarkable a degree. If we study the indigenous Flora of any district, we shall find that it is made up

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some Fossils from the Menevian Group, *ibid*. vol. xxiv. p. 510; *ibid*. vol. xxv. p. 51. "On the Ancient Rocks of St. Davids Promontory," by H. Hicks and Prof. Harkness, and "Descriptions of New Species," by H. Hicks, *ibid*. 1871, vol. xxvii. p. 384. "On some Undescribed Menevian Fossils," by H. Hicks, *ibid*. vol. xxviii. p. 173. "The Tremadoc Rocks of St. Davids," by H. Hicks, *ibid*. 1873, vol. xxix. p. 39. "On the Classification of the Cambrian and Silurian Rocks," by Henry Hicks, Proc. Geol. Association, 1873, vol. iii. p. 99.

[1] "History of the Names Cambrian and Silurian," GEOL. MAG. 1873, Vol. X. pp. 385, 463, 504, etc.; see also the "Canadian Naturalist," new series, vol. iv. p. 281, etc.

of certain families of plants, which not only thrive under similar conditions of soil and climate, but seem, in some remarkable manner, to depend upon one another—just as surely as amongst the Mammalia certain carnivora and herbivora are found associated in the same geographical areas.

It is by practically bringing to bear on fossil botany a correct and widely-extended knowledge of the mutual relations and geographical distribution of living plants over the earth's surface, that Heer and others have been guided in their otherwise almost forlorn task, and have revealed to us, in the most striking manner, the vegetation of our earth in the later geological periods.

It is now many years since Prof. Morris figured and described some small round bodies from Coalbrook-dale which he believed to be the sporangia of a *Lepidodendron.* These separate bodies were observed in great abundance in the coal-seams of Scotland, and were figured by Balfour and others. Goldenberg figured the same bodies as the fruit of *Sigillaria* attached to the inner surface of the somewhat dilated leaves of that plant. Carruthers discovered the small bodies in relation to the leaves of a lepidodendroid cone, to which he gave the name of *Flemingites,* considering them still to be sporangia, as there was no evidence of an investing spore-case. This view was further adopted by Huxley, when he lectured on the "Better-bed Coal" at Bradford, a bed almost made up of these small bodies.[1] Since then Binney has discovered a cone, in which the lower portion is occupied with the round bodies inclosed in spore-cases, and the upper portion by small spores, as in the living *Selaginellas.* Williamson has observed the same structure in a cone from Burntisland, and Mr. Carruthers has communicated to me a more perfect cone, in which not only is this arrangement exhibited, but the internal structure of the spores establishes that these cones agree in general structure with the perfect cone of *Triplosporites* described by Brongniart, and with the cones of *Selaginella,* and the reproductive organs of *Isoetes.*

The most conclusive evidence yet obtained as to the nature of the materials forming coal has been communicated to me by my colleague Mr. Carruthers. He obtained from a five-feet bed of coal at South Ouram, near Halifax, a number of calcareous concretions ("ball-stones") which in crystallizing inclosed the materials of the bed (which are all around converted into coal) before they were yet thus altered. Thin sections were prepared for microscopic examination, and they exhibit the fruits, leaves, stems, branches, roots, and rootlets of the ordinary plants of the Carboniferous period, such as Ferns, *Sigillaria, Lepidodendron, Calamites,* etc., in precisely the same condition as the plant-structures occur in beds of valley-peat forming at the present day—the difference being only in the kind of plants of which the two formations are composed. The coal then was not only a sub-aerial vegetable accumulation like peat, but itself formed a soil on which the vegetation continued to live.[1]

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[1] Prof. Huxley's generalization as to *all bituminous* coals being largely made up of these bodies has never been accepted by geologists, and is certainly opposed to many well-known and recognized facts regarding the formation of coal.

Before quitting the subject of Palæophytology, I would desire to direct your attention, in the briefest possible manner, to the eloquent discourse of Prof. Asa Gray,[2] delivered a year since to the American Association at Dubuque, Iowa, on the relation between Fossil Plants and the existing Flora of our Northern Hemisphere.

Prof. Gray describes the varied aspect of the great North American continent from the east to the west coast, and dwells especially upon the scenery of the westward slopes of the high mountain barrier, which, refreshed by the Pacific, bears the noble forests of the Sierra Nevada and the coast-range, and among them trees which are the wonder of the world.

"Although (says Dr. Asa Gray) no account and no photographic representation of either species of the far-famed *Sequoia* trees gives any adequate impression of their singular majesty—still less of their beauty—yet my interest in them did not culminate merely nor mainly in considerations of their size and age. Other trees in other parts of the world may claim to be older. Certain Australian Gum-trees (*Eucalypti*) are said to be taller. Some, we are told, rise so high that they might even cast a flicker of shadow upon the summit of the pyramid of Cheops. Yet the oldest of them doubtless grew from seed which was shed long after the names of the pyramid-builders had been forgotten. So far as we can judge from the actual counting of the layers of several trees, no *Sequoia* now alive can sensibly antedate the Christian era. . . . One notable thing about these *Sequoia* trees is their isolation. These 'redwoods' or 'big trees' belong to the Cypress family, but are *sui generis*. Thus isolated systematically, and extremely isolated geographically, and so wonderful in size and port, they more than other trees suggest questions.

"Were they created thus local and lonely denizens of California only; one in limited numbers in a few choice spots on the Sierra Nevada, the other along the Coast-Range from the Bay of Monterey to the frontiers of Oregon? Are they veritable Melchisedecs without pedigree or early relationship, and possibly fated to be without descent?

"Are they now coming upon the stage? Or are they remnants, sole and scanty survivors of a race that has played a grander part in the past, but is now verging to extinction? Have they had a career, and can we ascertain or surmise whence they came, and how and when?"

Prof. Asa Gray then proceeds to show that not many generations of *Sequoias* can have flourished just where they now are found, as there are all around abundant evidences of the very recent glaciation of the whole area.

He then endeavours to trace the former distribution of *Sequoia*—as attested by their fossil remains—in the Miocene formations of Northern Europe, Iceland, Spitzbergen, Greenland, Mackenzie River, and Alaska. The fossil species has been named *Sequoia Langsdorfi* by Heer, but it is *very much like S. sempervirens*, now living on the Californian coast, and is believed to be the ancient representative of it.

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[1] See "Relics of the Carboniferous and other Old Land-surfaces" by H. Woodward, Proc. Geol. Association, 1872, vol. ii. p. 231.

[2] Silliman's American Journal, October, 1872, p. 282.

Three species at least of this giant Coniferous tree flourished in Tertiary times within the Arctic zone; the commonest of which has also been found in Europe.

So the Sequoias, now so remarkable for their restricted station and numbers, as well as for their extraordinary size, are of an ancient stock; their ancestors and kindred formed a large part of the forests which flourished throughout the polar regions now desolate and ice-clad, and which extended into low latitudes in Europe.

After enumerating a number of other cases of existing plants which have been found associated with both the living and extinct *Sequoia*, he concludes that our existing vegetation as a whole is a continuation of that of the Tertiary period, and that this, in its turn, has been derived from the preceding flora—Mr. Carruthers having met with two Cretaceous fossil fruits like those of *Sequoia gigantea* of the famous groves, associated with pines of the same character as those that accompany the present tree; whilst two or more *Sequoias* have been met with in the Cretaceous beds of Greenland.

According to these views, as regards plants at least, the adaptation to successive times and changed conditions has been maintained, not by absolute renewals, but by gradual modifications.

Prof. Asa Gray has no doubt that the present existing species are the lineal successors of those that garnished the earth in the old time before them, and that they were as well adapted to their surroundings then as those which flourish and bloom around us are to their conditions now. Order and exquisite adaptation did not wait for man's coming, nor were they ever stereotyped.

(*b*.) *Palæozoology*.—A review of the progress of Palæozoology would be most incomplete and unsatisfactory were no allusion made to the Palæontographical Society, which was established in the year 1847, for the purpose of figuring and describing the *whole* of the British Fossils. Right nobly has the task been carried on since that date, and twenty-six large annual volumes attest in the most substantial manner the stability of the work.

Much of the success of the Palæontographical Society during these later years has resulted from the unwearied attention and energy bestowed upon its management by the present Honorary Secretary, the Rev. Thomas Wiltshire, M.A., F.G.S., whose zeal in promoting the regular publication of its volumes has produced the most beneficial results to the Society.

Already 3933 British species have been described, in 7224 quarto pages of letterpress, accompanied by 1103 plates, containing 20,237 figures.

Prominent among the workers in this unpaid labour of scientific love will always stand the names of Bowerbank, its original promoter, and Searles Wood, Owen, Bell, and Frederick Edwards, its earliest promoters and *contributors*. Following these in chronological order come Rupert Jones, King, Milne-Edwards, and Jules Haime, Morris and Lycett, Davidson, Darwin, Forbes, Daniel Sharpe, Dr. Wright, Busk, Salter, Phillips, Boyd-Dawkins and Sandford, Parker and Brady, E. W. Binney, Woodward, Lankester. Of this long list of palæontologists, three names stand out in connexion with this Society pre-eminent for hard untiring energy extending over more than a quarter of a century—men who are, happily for us, *still numbered* among our scientific workers. They are Thomas Davidson, Searles V. Wood (the venerable Treasurer of the Society), and Prof. Owen.

The first of these, Davidson, has contributed 1368 pages of letterpress, and has drawn 6530 figures of Brachiopoda *with his own hands.*

Searles Wood has monographed the Mollusca of the Crag and the Bivalves of the Eocene—making 872 pages of letterpress. Owen has given 796 pages of text with appropriate plates on the Reptilia and Mammalia. Of these it may be said truly—

"*Si monumentum requiris—circumspice.*"

In connexion with my researches in fossil *Limuli*, I would briefly allude to two valuable contributions to the anatomy of the "King-Crab," of the North-east coast of North America—one by my distinguished colleague and chief, Prof. Owen, published in the Linnæan Transactions for this year;[1] the other by Prof. Alph. Milne-Edwards in the Annales des Sciences Naturelles.[2]

Limulus polyphemus of North America, and the closely allied species common to the Moluccas and the coasts of China and Japan, is the sole existing type of this ancient race, whose longevity as an Order in time is unsurpassed among the Crustacea, save by the Entomostraca alone—*Neolimulus* of the Upper Silurian of Lanark closely agreeing with one of the larval stages of the living *Limulus*, as made known by the researches of Packard[3] and Dohrn.[4]

As I shall fully treat of this subject in Part V. of my Monograph of the MEROSTOMATA, now preparing for publication, I refrain from dwelling upon them here at greater length.

Among the many contributions lately made to our knowledge of extinct forms of vertebrate life, those by Prof. Owen take precedence, both in number and importance.

In a recent communication to the Royal Society (Phil. Trans. 1872, p. 173), Prof. Owen describes the remains of seven species of Wombat from Darling Downs, Queensland, preserved in a lacustrine deposit, associated with living species of *Melania* and other freshwater shells. These do not so greatly exceed in size the existing species; but in a second paper (Phil. Trans. 1872, p. 241) the author describes the remains of two very large species under the names *Phascolomys magnus* and *P. gigas*:—

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[1] Trans. Lin. Soc. 1873, vol. xxviii. pt. iii. p. 459, plates xxxvi. to xxxix.

[2] Ann. des Sc. Nat. Zoologie et Paleontologie, 1872–3, 5th series, tome xvii. p. 25, plates v. to xvi.

[3] "The Development of *Limulus polyphemus*," by A. S. Packard, jun., M.D., Mem. Boston Soc. Nat. Hist., 1872, vol. xi. pp. 155–202, pl. iii.–v.

[4] "Zur Embryologie und Morphologie des *Limulus polyphemus*," von Dr. Anton *Dohrn*, Jenaische Zeitschrift, 1871, Bd. vi. Heft 4, p. 580, Taf. xiv. and xv.

"Until comparatively lately," writes Prof. Owen, "the Wombat was known to zoologists as a solitary exceptional form of small Tasmanian Marsupial, peculiar in its scalpriform dentition, combined with burrowing habits. We now know this generic form under many specific structural modifications, and with gradations of bulk rising from that of a Marmot to that of a Tapir!

"The rodent type of incisors, both as to number and kind, are retained in all, certainly in the lower jaw of the gigantic species; but it would not be safe to infer that these extinct forms burrowed, like the smaller living Wombats.

"If we knew the Hare (*Lepus timidus*) only by fossil remains, we should err in attributing to it the habits and mode of life of the smaller species (*Lepus cuniculus*), the Rabbit. It is probable that the larger extinct Wombats did not conceal themselves underground."

"Of the series of *Phascolomys*, the *larger* ones have all perished. Here, as in the case of the gigantic wingless birds of New Zealand, size and bulk seem to have been a disadvantage in the 'contest for existence.' The small burrowing 'Kivis' (*Apteryx australis*, Shaw, and *Apteryx Owenii*, Gould), like the small wombats, have survived.

"The extirpating cause of the larger wombats, especially if they were unable to take refuge and conceal themselves underground, was probably the hostility of man. No human remains, however, or weapons, have yet been discovered in the stalagmitic breccias of the caves, or in the freshwater deposits of Australia. But as the unseen planet may be inferred by evidence of its force, so may the destroyer be conjectured, and his discovery anticipated by the effects of his power—such, for example, as the disappearance of species which, from their easier detection, capture, or bringing to bay, and greater profit when slain, would be the first objects of chase to the primitive *Aborigines*." (Owen, op. cit. p. 255.)

In 1839 Prof. Owen drew attention to a "bone of an unknown Struthious Bird of large size presumed to be extinct," stated to have been obtained from New Zealand.

Since that date various naturalists, collectors, and colonists have sent home remains of this bird in such profusion that 17 species (or probably more correctly speaking *varieties*) have been described by the same indefatigable anatomist.

To this interesting series Prof. Owen has now added the evidence of the existence of another extinct Struthious bird, not from New Zealand, but from the great Island-Continent of Australia. The femur of this bird, described and figured (Trans. Zool. Soc. 1873, vol. viii. pt. 6) by Prof. Owen, agrees in size with that of *Dinornis elephantopus* (although from comparison of the details of its parts he determines it to be generically distinct). He names it *Dromornis australis*, and suggests the possibility of its having been *ancestrally* contemporary with the impressors of the *Ornithicnites* of Connecticut.

Some time since (Trans. Zool. Soc. 1870, vol. vii. p. 123) the same author drew attention to the cranium of another large extinct Struthious bird from the London Clay of Sheppey, which he named *Dasornis Londinensis.*

The distribution of these great Struthious birds has a deep significance for the thoughtful palæontologist, who cannot fail to see in it a problem worthy of his study. Africa has its Ostrich;[1] Madagascar had its *Æpyornis;* Java and the adjacent islands of the Indian Archipelago the Cassowary; Australia its Emu and extinct *Dromornis;* New Zealand its *Dinornis;* South America its *Rhea;* the London Clay its *Dasornis Londiniensis.* Thus then we have this most ancient type of wingless running birds presenting not merely the greatest range in time but also the widest geographical distribution over the globe of any order of its class.

M. Alphonse Milne-Edwards has, for twelve years past, carried on a most important series of researches on Fossil Birds. The new facts which he has recorded have to some extent confirmed the results to which a study of the fossil Mammalia and Reptilia has led, and they have enabled us to appreciate more fully the physical conditions of the globe at these remote epochs.

Among the chief recent discoveries must be included the very remarkable fossil Bird, the *Ichthyornis dispar* (Marsh), discovered by Prof. O. C. Marsh, in 1872, in the Upper Cretaceous beds of Kansas, U.S. It possessed well-developed teeth in both jaws, which were quite numerous, and implanted in distinct sockets. The teeth were small, compressed, and pointed, and all similar in character. Those in the lower jaws number about twenty in each ramus, and are all more or less inclined backward. The series extends over the entire upper margin of the dentary bone, the front tooth being very near the extremity. The maxillary teeth appear to have been equally numerous and essentially the same as those in the mandible. The jaws were, apparently, not encased in a horny sheath. The bones of the wings and legs all conform to the true ornithic type. The vertebræ were all biconcave, the concavities at each end of the centra being distinct and nearly alike. The tail was not preserved. The bird was about the size of a pigeon. The bones do not appear to have been pneumatic, although most of them are hollow. The species Prof. Marsh considers was carnivorous and probably aquatic.

A second form discovered has been named *Apatornis celer* (Marsh).

Prof. Marsh thinks it probable that *Archæopteryx* possessed teeth and biconcave vertebræ. In confirmation of the former suggestion, it may be mentioned that part of a small detached jaw with teeth may be seen upon the slab containing the skeleton, and possibly may have belonged to it, although referred by Prof. Owen to the "premaxillary bone of a fish."[2]

Prof. Owen has added to his researches another Eocene bird from the London Clay of Sheppey,[1] to which his attention had been drawn by Mr. W. Davies, of the British Museum, who also worked it out with his own hands.

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[1] The range of the African Ostrich was formerly much greater. It extended into Arabia, Persia, and part of India, within the human period, but has been killed off by man.

[2] Phil. Trans. 1863, p. 33. See also article by H. Woodward in *Intellectual Observer*, Dec. 1862, vol. ii. p. 313, and plate; and by S. J. Mackie, *Geologist*, 1863, vol. vi. p. 1.

This bird, which he has named *Odontopteryx toliapicus*, is rendered remarkable by the very prominent denticulation of the alveolar margins of the jaws, to which its generic appellation refers.

The denticulations are intrinsic parts of the bone bearing them, and are of two sizes, numerous smaller denticles occupying the spaces between the larger ones, which are about half an inch apart.

When perfect the skull was probably five to six inches in length, but the anterior extremity is wanting.

Prof. Owen concludes *Odontopteryx* to have belonged to or near the *Anatidæ*, and that it was web-footed and a fish-eating bird, for which its serrated jaws would admirably adapt it.

As we have not the other parts of the bird, but the skull alone, it would be presumptuous to surmise as to the presence or absence of other modifications beside the pseudo-teeth with which the jaws are armed.

From the extreme rarity of all terrestrial animal-remains preserved in a fossil state, it may justly be concluded that many more such archaic birds, having reptilian modifications, actually existed in the Mesozoic epoch, although they may possibly never be discovered by geologists.

Much of the recently acquired knowledge of the huge *Dinosauria* of our own Secondary rocks has resulted from the earnest labours of Professor Phillips, bestowed upon the remarkable series of remains in the Oxford Museum.

Mr. J. W. Hulke, F.R.S., has likewise devoted much time and care to the examination of *Hypsilophodon* a genus of Dinosaurs closely related to *Iguanodon*, the detailed anatomy of which he has now in great measure completed. Under the name of *Cetiosaurus humero-cristatus* he has also described a gigantic humerus of a Dinosaur from the Kimmeridge Clay, Weymouth, rivalling in size the largest humerus in the Oxford Museum. This specimen is about to be secured for the British Museum.

We know certainly now that the *Megalosaurus*, that huge carnivorous lizard, perhaps 30 feet long, which ranged from the Lias to the Wealden, had strong but not massive hind-limbs, and short reduced fore-limbs, five anchylosed sacral vertebræ (Owen), the ilium, ischium and pubis, slender and bird-like, as in the Ostrich: the scapula and coracoid resembling those of the *Apteryx*. From all these the conclusion of Professor Phillips agrees with Profs. Owen and Huxley in viewing the *Megalosaurus*, "not as a ground-crawler, like the alligator, but moving with free steps, chiefly if not solely, on hind-limbs, and claiming a curious analogy, if not some degree of affinity, with the Ostrich."[2]

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[1] See the Quart. Journ. Geol. Soc. 1873, vol. xxix. p. 511, pl. xvi. and xvii., and abstract in GEOL. MAG. for August last, p. 376.

[2] "Geology of Oxford and the Valley of the Thames," by John Phillips, M.A., F.R.S., F.G.S., etc., 1871, p. 196.

What we have cited as regards the carnivorous *Megalosaurus* is true also of the vegetable-feeding lizards of the Mesozoic rocks (the *Iguanodon*, *Scelidosaurus*, etc.).

The sacrum is composed of from four to six vertebræ. The pelvic bones are bird-like in form and disposition; there is a strong crest which passes between the head of the fibula and the tibia, as in birds. The tibia has a great anterior or "procnemial" crest, not seen in other reptiles, but existing in most birds, especially the running and swimming birds. The toes are reduced in number; *Scelidosaurus* has four toes and a rudiment of a fifth. *Iguanodon* has *three*, with a rudimentary indication of a fourth.

There is evidence in "the manner in which the three principal metatarsals articulate together, that they were very intimately and firmly united, and that a sufficient base for the support of the body was thus afforded by the spreading out of the phalangeal regions of the toes." Mantell long since, and more recently Cope and Leidy, have concluded from the great difference in the size between the fore- and hind-limbs, that *Iguanodon*, *Lælaps*, and *Hadrosaurus*, as well as other *Dinosauria*, may have supported themselves for a time at least upon their hind-legs. But Mr. Beckles' discovery of pairs of large three-toed foot-prints, of such a size and at such a distance apart that it is difficult to believe they have been made by anything but *Iguanodon*, leads to the supposition that this vast reptile, and perhaps others of its family, must have walked temporarily or permanently upon its hind-legs. (Huxley, in GEOL. MAG. 1868, p. 364.)

Many years since Mr. Allan Cunningham, who accompanied the Expedition to Survey the Intertropical and Western Coasts of Australia, from 1818 to 1822, under Captain Philip King, R.N., F.R.S., secured a specimen of a remarkable Frilled Lizard, which had *perched* itself upon the stem of a small decayed tree, at Careening Bay, Port Nelson,[1] which has been named *Chlamydosaurus Kingii*, by Dr. Gray. The specimen is preserved in the British Museum collection in a semi-erect position, its fore-feet (which are *very much smaller* than the hind-feet) scarcely touching the ground at the extremities of the claws. The lizard in question habitually runs *upon the ground* on its *hind-legs*, its fore-paws not touching the earth. As geologists, we cannot but be interested in this peculiarly modified existing lacertilian, occurring as it does on the continent of Australia, which has already yielded such a remarkable assemblage of Tertiary and existing Marsupialia—a land also remarkable for the possession of many living Mesozoic types of Mollusca on its coasts.

Viewed by the additional light which our present knowledge of the structure of the Mesozoic *Dinosauria* and of the existing *Chlamydosaurus* affords, we need no longer be doubtful as to the origin of the many bipedal tracks which occur in the Trias and other Secondary strata.

Some are very probably the "spoor" of Struthious birds which may have existed fully as far back as the beginning of the Secondary

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[1] See King's Survey of Australia, 8vo., 1827, vol. ii., Appendix, p. 424.

Period, but most are no doubt due to the bipedal habit of our Secondary reptiles—a peculiarity still maintained by the Australian *Chlamydosaurus.*

A very exhaustive paper, "On the Mammalia of Europe at the close of the Miocene Epoch," has appeared from the pen of Prof. Albert Gaudry, which is well deserving the consideration of palæontologists.

M. Gaudry is led, from his extensive studies of the fossil Mammalia, to conclude that, as the majority of allied species occurring at different geological ages have a greater number of points of resemblance than of difference, it is more reasonable to derive the later from the pre-existing species than to destroy the earlier in order to replace them by the later. Species, according to his view, have not a distinct origin, but are derivatives of the same type which has undergone slight modifications.

It is gratifying to find that the more advanced Naturalists in France, of whom M. Gaudry is a type, are advocates of the Doctrine of Descent with Modification. It is not so long since our distinguished fellow-countryman, Darwin, was strongly opposed when recommended for the honour of admission to the Institute of France on account of his holding the very views propounded by M. Gaudry.

It cannot be doubted that the majority of Botanists and Zoologists seem alike disposed to accept the Doctrine of Evolution and Descent with Modification. There are still some scientific men, however, who find the derivative origin of species by descent repugnant to their ideas. For the opinions of such I have the greatest possible respect, feeling sure that, up to a certain point, controversial opposition to new theories has its beneficial aspect in ridding us of worthless notions. But Darwin's theory has already passed through the fire —like crude ore it has been washed, sifted, crushed, roasted, and smelted, and at the end the pure metal remains.

The only question is one of terms and names. Prof. Owen, who is himself a most advanced Evolutionist, if we may be permitted to judge of his views by his published works, prefers to hold the conviction that all forms and grades of both vertebrate and invertebrate life are due to "Secondary Cause or Law," not to "Natural Selection."

Upon the nature of these very delicate and baffling distinctions I feel myself quite unable to enter on the present occasion.

To the earnest seeker after truth, it can never be an irreverent or idle object to investigate the process by which life has been gradually evolved on our earth; when, however, we have learned all that is in our power to discover, there is still the great problem of LIFE itself unsolved, and we stand upon the threshold of the Infinite.

I cannot believe that such inquiries, if honestly and earnestly pursued, will ever lead the student into an unhealthy mental atmosphere; nor can it narrow or debase his mind to be brought more intimately into contact with all that is grand and beautiful in the natural world around him.

Professor Asa Gray, whose excellent address I have already had occasion to quote, truly observes—"Through what faults or infirmities of dogmatism on the one hand, and scepticism on the other, it came to be so thought, we need not here consider. Let us hope and confidently expect that it will not last; that the religious faith which survived without a shock the notion of the fixity of the earth itself, may equally outlast the notion of the absolute fixity of the species which inhabit it; that in the future, even more than in the past, faith in an *order*, which is the basis of Science, will not (as it cannot reasonably) be dissevered, from faith in an *Ordainer*, which is the basis of Religion."

My self-imposed task is ended—how imperfectly it has been fulfilled no one is more conscious than myself; but if I have by this means succeeded in attracting your attention to a few of the vast number of lines of scientific inquiry stretching into the universe around, along which the intellectual powers of man are striving to advance, and upon which we also may become travellers, I shall not have spoken altogether in vain.

II.—ON A NEW GENUS OF FOSSIL FISH OF THE ORDER *DIPNOI*.[1]

By RAMSAY H. TRAQUAIR, M.D.,
Professor of Zoology in the Royal College of Science, Dublin.

(PLATE XIV.)

AGASSIZ, after describing the intermaxillary bone of *Megalichthys*, makes the following brief statement regarding the fossil which is the subject of the present paper: "M. König possède une pièce detachée qui parait etre le même os." [2]

This "pièce detachée" is in the collection of the British Museum, and has lately been completely wrought out by removal of the remains of the matrix, in which it was imbedded. It was shown to me some time ago by my friend Mr. Henry Woodward, who expressed to me, at the time, his own opinion that it could not belong to *Megalichthys*, but that it was in all probability a new genus. In this opinion I entirely concurred, as it was at the first glance evident that it could not belong to the *Saurodipterine* group, of which *Megalichthys* is a member, although certain parts did exhibit a very brilliant punctated Ganoid surface, reminding us of the polished plates and scales of that genus. On the contrary, fragmentary as the fossil unfortunately is, its configuration shows that it must be closely allied to *Dipterus*, and must therefore be included in the order *Dipnoi*; the close relationship between *Dipterus* and the living *Ceratodus* and *Lepidosiren* having been already clearly shown by Dr. Günther.[3]

The specimen before us is, as aforesaid, only a fragment, measuring 1½ inches in length by 3 in breadth, and is evidently the extremity of the snout of a very large fish, probably 4 or 5 feet long. It is of a somewhat semilunar form; showing a rough *posterior* margin where it has been broken off from the rest of the head; a *superior* arched ganoid surface, which has formed part of the upper aspect of the eol. Mag. 1873. Vol. X. Pl. XIV.

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[1] Read before the Royal Geological Society of Ireland, 14th May, 1873.

[2] Poissons Fossiles, vol. ii. part 2, p. 91.

[3] Phil. Trans. 1871.

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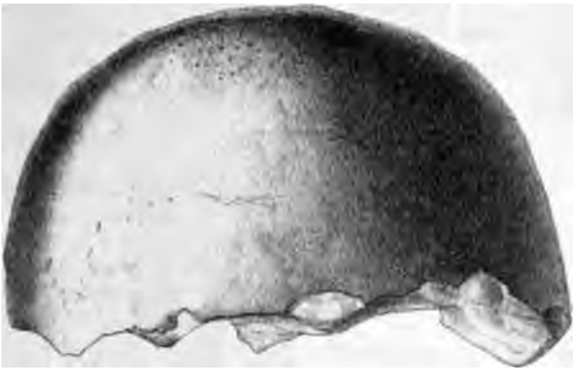

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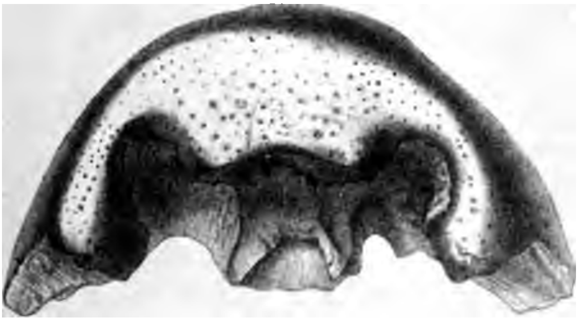

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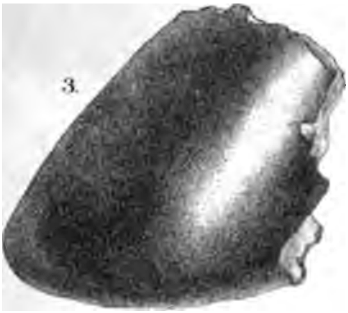

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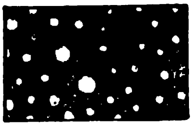

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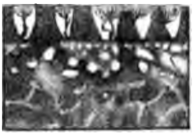


A T Hollick del et lith [illegible]

To illustrate Prof. Traquairs' paper

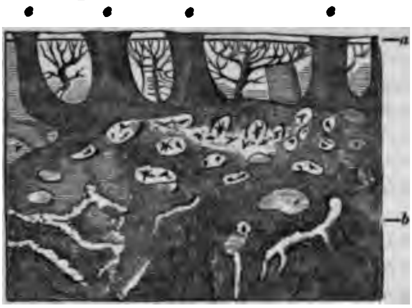
snout; an anterior margin forming the front edge of the upper lip; and an inferior excavated surface, which formed part of the roof of the mouth and nasal chambers. Placing the snout in its natural position, with the labial margin horizontal (Pl. XIV. Fig. 3), the superior surface is seen to slope downwards and forwards in the middle line at an angle of 45°, while towards the sides it is rounded off in an arched manner. This surface shows no trace either of sutures or of external nasal openings; it is smooth and ganoid, glossy and finely reticulate-punctate; near the labial margin, however, the minute punctures disappear, and are replaced by another set, which are larger, fewer, and further apart. Many of these larger punctures are also seen on the finely-reticulate surface above.

On turning up the fossil, and looking at it from below (Fig. 2), we see first a flattened margin, situated in front and laterally, which must have formed part of the upper lip, and which passes by a rounded edge over to the upper surface just described. This labial margin is brilliantly polished, and ornamented with the large scattered punctures already alluded to, and which average about $\frac{1}{50}$ inch in diameter. It shows also on each side and internally a pretty deep rounded notch, clearly indicating the position of an anterior nasal opening, which must thus have penetrated the upper lip as in the living *Dipnoi.* This arrangement also agrees perfectly with what is seen on the under aspect of the snout of *Dipterus.* The portion of the labial margin situated between the right and left nasal notches shows a faint median indentation, dividing it into two parts, and each of those parts, right and left, is set on its rounded posterior edge with a row of six small blunted tooth-like projections. Similar blunted tooth-like bodies are also seen on the inner aspect of the projecting portion of the labial margin behind each nasal notch.

Posteriorly and internal to this strange ganoid labial margin, the specimen is deeply excavated, and the surface here seen has evidently formed part of the roof of the nasal chambers on each side, and of the front of the roof of the mouth. The bone is here rough; no sutures can be distinguished; but the median longitudinal projecting portion evidently represents the front of the vomer, anterior to the attachment of the palato-pterygoid plates. No trace is seen of vomerine teeth, as in *Ceratodus* and *Lepidosiren,* nor of their places of attachment as noticed by Günther in *Dipterus*; if present in this fish, they must also have been posterior to the portion preserved.

The hinder margin, all the way across between the two posterior angles of the specimen, shows nothing but the rough fractured surface where it has been broken off from the rest of the head. However, we may see here that the bone, forming the surfaces just described, exists as a rather thin shell over an internal space once occupied beyond doubt by cartilage, now completely filled up by the stony matrix, a dull grey argillaceous limestone. But the part between the posterior angle of the specimen, on each side, and the boss-like dentigerous projection behind each nasal notch, shows a distinct articular surface looking backwards, and which may have been for a maxillary bone, or for a superficial facial bone if the maxillary were wanting, as is the case in the recent *Dipnoi*, and apparently also in the fossil *Dipterus*.

A thin vertical slice, taken from the bone on the upper surface near the posterior external angle, displays microscopic characters essentially similar to those found in the scales and plates of many ganoid fishes, including also the scales of *Megalichthys*. The bone is here very thin, measuring only about $\frac{1}{40}$ inch in vertical section. Its microscopic structure is represented in the accompanying woodcut. Immediately below the surface is an absolutely structureless layer of transparent ganoine about $\frac{1}{1000}$ inch thick. Through this the punctures of the surface pass into a set of short vertical canals, each widening downwards so as to assume a rather conical figure. At their bases they are connected by horizontal tubes, and this system also communicates below with a close irregular network of ordinary Haversian canals, which ramify through the lower part of the section, and, becoming coarser below, cause the bone on its inferior aspect to assume almost a spongy appearance. The intervals between the set of short wide vertical canals, cup-shaped in the section, are seen to be each traversed by a vertical tube, which, coming up from the Haversian network below, soon divide in an arborescent manner into a great number of minute ramifying branches, which pass towards but not into the superficial layer of structureless ganoine. Adjacent trees of this kind also freely communicate with each other by means of arched branches, passing around and between the vertical canals between which their stems are situated. A beautiful kosmine-like layer is thus formed below the ganoine; it must be noted, however, that small lacunæ are occasionally seen among its minute tubules. In the true bone below, lacunæ of the ordinary type abound in the meshes of its Haversian network.



Vertical section of bone on the upper surface of the snout, magnified 48 diameters.
a Layer of ganoine. b True bone.
c Punctures of the surface—opening into the canal system of the interior.

Unfortunately nothing is known regarding the geological formation, or the locality, of the fossil just described. To Mr. Davies, of the British Museum, I am indebted for the information, that it "formed part of the old collection of the British Museum, of which there are no records, hence its history as to from whom, and whence it came is wanting." Judging, however, from its general aspect, one might readily be tempted to infer that it was of Palæozoic age.

SECTION II. RETIOLOIDEA.

er developed from a siculiform "germ."			
iginating a double series of thecæ.			
re or less supported by a **framework of chitinous filaments.**			
II.—*Glossograptidæ* (provisional Family).			
Virgulæ coalescent, placed centrally within the body of the polypary.			
Angles of the walls of the thecæ partly strengthened by chitinous filaments, which are prolonged as distinct or anastomosing lateral processes.			
Periderm continuous, thickened.			
Polypary simple, usually furnished with two opposite, longitudinal rows of distant, isolated spurs or lateral appendages, developed along the median line of the periderm at right angles with the thecæ.			
(I.) Without extraneous meshes.			
Thecæ resembling those of *Orthograptus*.	23. Gen. GLOSSOGRAPTUS (Emmons).	,,	(*G. ciliatus*, Emm.).
(II.) With extraneous meshes.			
i. Extraneous meshes formed by single, simple filaments, developed from the anterior margins of the apertures.			
Thecæ resembling those of Retiolites.	24. Gen. RETIOGRAPTUS (Hall).	,,	(*R. tentaculatus*, Hall).
ii. Extraneous meshes formed by numerous anastomosing filaments, developed from simple spinous processes from the outer walls of the thecæ.			
Thecæ resembling those of *Climacograptus*.	25. Gen. LASIOGRAPTUS (gen. nov.).	,,	(*Las. costatus*, sp. nov.).
Fam. VIII.—*Retiolitidæ*.			
Virgulæ separated and placed one on the obverse, the other on the reverse aspect of the polypary; and forming an integral portion of the filiform framework.			
Epiderm stretched upon a complete skeleton framework of chitinous threads.			
(I.) Periderm excessively attenuated.			
a. Periderm reduced to a scarcely appreciable film.			
i. Polypary simple.	26. Gen. CLATHROGRAPTUS (gen. nov.).	,,	(*C. cuneiformis*, sp. nov.).
ii. Polypary compound.	27. Gen.	,,	(*Ret. eucharis*, Hall sp.).
b. Periderm punctate.			
Polypary simple.	28. Gen. TRIGONOGRAPTUS (Nich.).	,,	(*T. ensiformis*, Hall sp.).
(II.) Periderm reduced to a network.			
Polypary simple.	29. Gen. RETIOLITES (Barr.).	,,	(*R. Geinitzianus*, Barr.).

From the preceding description it is evident that the fish, to which this strange and beautiful snout belonged, must take its place, not among the Ganoids proper, but among the *Dipnoi*. Of fossil fishes **hitherto** reckoned with certainty to the last-named order, we have **only** *Cheirodus*, *Dipterus*, *Ctenodus*, and *Ceratodus;* the position of *Phaneropleuron* and *Tristichopterus* being still doubtful. Our fossil is certainly neither *Dipterus* nor *Ceratodus; Cheirodus* is known only by its teeth; and as to *Ctenodus*, the front of the head has not yet been discovered, so that all evidence is wanting to connect it with that genus. It seems therefore, in these circumstances, best to frame a new genus for its reception; I propose, therefore, to bestow upon it the generic term *Ganorhynchus* (γάνος, ῥυγχος), coupled with the specific name of *Woodwardi*, in honour of the distinguished palæontologist who first directed my attention to the fossil.

EXPLANATION OF PLATE XIV.

Fig. 1.—Upper surface of the broken-off snout of *Ganorhynchus Woodwardi.*

Fig. 2.—Lower aspect of the same fossil, showing the ganoid and pitted labial margin, the anterior nasal notches, portion of the roof of the nasal chambers, and the broken-off vomer in the centre.

Fig. 3.—The same fossil seen from the left side. At the posterior inferior angle is seen the articular surface referred to at page 553. Both of these surfaces, right and left, are seen in Fig. 2, at the posterior external angles.

Fig. 4.—A magnified view of the smooth ganoid surface of the upper lip, showing the large scattered punctures or pits with which it is ornamented.

Fig. 5.—A microscopic section of the ganoid bone on the upper surface of the snout. This drawing, executed in the absence of the author from Great Britain, does not convey a very accurate or intelligible idea of the microscopic structure; the woodcut, page 554, has therefore been substituted.

III.—Notes on the British Graptolites and their Allies.

By Chas. Lapworth, F.G.S.

1.—On an improved Classification of the Rhabdophora.[1]

PART II.

THE accompanying analytical Table of the genera of the *Rhabdophora* which are especially treated of in the present paper is here offered as a first and suggestive sketch for an improved arrangement of these forms. The foregoing conclusions have been employed in its construction, and are embodied in the general scheme. See Table I.

Of the several families under Mr. Hopkinson's well-known plan of arrangement, the first (*Monoprionidæ*) comprises the whole of the species distributed among the first three families in the Table. The *Tetraprionidæ* and *Mono-di-prionidæ*, as finally interpreted by himself,[2] are identical with two of the new families. Thus the alteration in this section is more apparent than real. It is a great proof of the value of Mr. Hopkinson's original classification that subsequent research has necessitated such a slight change in this department. In his scheme, however, the families were each founded upon a single structural peculiarity. The corresponding nomenclature was so precise and inflexible that it admitted of no modification or intercalation. In the proposed arrangement, on the contrary, the families are constituted by assemblages of species, linked together by a large community of morphological characters, and grouped around typical genera. The most characteristic genus in all cases furnishes the name for the family. The new scheme therefore admits of modification in matters of detail, or of the intercalation of new families, which the exigencies of science will certainly demand, in proportion as future research throws light upon doubtful points of structure, or furnishes us with certain evidence of the methods of multiplication and reproduction, among these ancient creatures.

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[1] For Part I. See Geol. Mag. Vol. X. pp. 500–504. [2] Geol. Mag. Vol. X. p. 231.

The arrangement of the monoprionidian forms in the present scheme is, upon the whole, the natural one, and this view of their relationships is strikingly confirmed by the known geological distribution of the genera constituting the several "families." The latter are well circumscribed, and the slightest fragment of the branch of a monoprionidian species can be referred at a glance to its proper family. It was with great pleasure that I learnt from Mr. Hopkinson at the beginning of the present year, that he had independently arrived at a similar classification of these uniserial forms. To this eminently acute observer must also be assigned the credit of being the first in acknowledging the propriety and value of Professor Hall's separation of *Didymograptus* and *Dicellograptus*, and in carrying it out to its proper limits. His views upon these points are adopted in the Table. He was also the first to call attention to the fact that *Leptograptus flaccidus* (Hall sp.) could rightly be referred to neither of the foregoing genera, but more probably belonged to the genus *Nemagraptus* of Emmons.[1] The importance of his clear recognition of this circumstance, which may be said virtually to contain within itself the clue to the differentiation of the well-marked group of the *Nemagraptidæ*, I have in some degree endeavoured to acknowledge, by relinquishing my proposed title for this family, in favour of the MS. name applied to it by Mr. Hopkinson.

The classification of the Graptolites with two ranges of thecæ (*Diplograptidæ*), although in my opinion the best possible in the actual state of our knowledge, is to be regarded as confessedly temporary and provisional. Not only are the limits of the major divisions badly defined at present, but the minor grouping we are compelled to adopt is essentially artificial. Indeed it may be considered certain that future research will demonstrate the necessity for a very different distribution of many of these forms.

All that is attempted in this department is roughly to prepare the way for the next and future advance in the proper classification of these species. This will probably consist in the suppression of the family *Phyllograptidæ*, whose single genus may have to be included among the *Diplograptidæ*. From the latter it may ultimately be necessary to eliminate the genus *Climacograptus*, and to place it, together with *Lasiograptus*, near the family of the *Dicranograptidæ*. There is also evidence in support of the view that the more typical species of

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[1] Geol. Mag., Vol. VIII., p. 64.

Orthograptus, which have as yet offered no trace of a true sicula, belong in reality to the *Glossograptidæ*.

The genus *Diplograptus* is here divided into several sub-genera. This will be found of service in enabling us to group together, for convenience of reference, species having a certain amount of similarity in their external features. It will also have the further advantage of necessitating such close attention to those minor, and hitherto neglected points in outward form dependent upon internal structure, as may result in the detection of the true relationships of the very different fossils which are at present associated in this badly understood genus; and ultimately furnish us with the means of accurately defining the exact line of separation between the two great sections of the RHABDOPHORA.

The distinguishing characteristics of these sub-genera will, it is hoped, be sufficiently apparent from the analysis in the Table, and from the references to the typical species.

Regarding the controverted question of the relationships which exist between the *Diplograptidæ* and the genus *Retiolites* and its allies, it must be admitted that, trenchant as are the apparent distinctions in mode of development and general plan of structure which characterize these two sections, yet every new investigation results in the detection of fresh and striking correspondences in detail of form or structure. A full consideration of these numerous points of contact may here be dispensed with. It will be sufficient for the present merely to call attention to the following facts.

While in some Retioloid species the virgula is either entirely wanting, or is represented by a slender thread forming a portion of the external network, in others it appears to be a stout double rod, comparable in all respects with the virgula of the duplicate Graptolites.

Some siculate Graptolites have the outer angles of their thecæ in part strengthened by a chitinous thread, a structural feature especially characteristic of the *Retiolitidæ*.

In some forms of the *Diplograptidæ* the polypary on its obverse aspect presents us with a well-defined suture, while on its reverse aspect the periderm offers no trace whatever of a central groove, but is entire and unbroken; leading us to conclude, that in these abnormal specimens the common canal was only partially divided: thus in effect communicating with both rows of thecæ as in *Retiolites*.

On the other hand, in some true Retioloid species, the two lateral halves of the polypary fall asunder after death, remaining attached by their proximal ends only: thus presenting us with a form which, excepting in its reticulate structure, irresistibly reminds us of *Dicranograptus*, a genus notably illustrative of the duplicate nature of the polypary in the *Diplograptidæ*.

For these and many other reasons, some of which will become apparent on a study of the Table, it is evident that the great groups of the siculate and non-siculate *Rhabdophora* afford so many minor structural correspondences that no scheme of classification having any pretence of representing, even approximately, the order of nature, but must place them in immediate proximity in the general arrangement. On the other hand, the two groups differ so greatly as a whole, in the early stages of their development, and in the general ultimate structure of the adult polypary, that we are certainly justified in considering them as forming two separate sections of the *Rhabdophora*. To the first of these sections the term GRAPTOLITIDÆ[1] should be restricted. For the second section I propose the title of RETIOLOIDEA.

It is impossible on the present occasion even to glance at the remaining differences in matters of detail between the present and former schemes of classification. One only will finally be noticed. The genus *Glossograptus* as here received includes all those peculiar forms furnished with the lateral appendages referred by Hall, Hopkinson, and Allman to the reproductive system of the Graptolites. While their apparently numerous points of affinity with the true Graptolites (*Graptoloidea*) cannot for a moment be denied, yet their internal structure furnishes incontrovertible evidence that they are most intimately related to the *Retioloidea*.

Future alterations in the arrangement of the *Rhabdophora* will in all likelihood be mainly dependent upon elements of classification derived from our improved knowledge of their various methods of multiplication and reproduction. Whatever evidence is at present afforded by our very limited acquaintance with these subjects has been, from its very vague and uncertain character, virtually ignored in the Table. The indications it gives of defects in the present scheme bear wholly upon the families *Diplograptidæ* and *Glossograptidæ*. Many of the species here associated with those of the former will probably have to be eliminated and located elsewhere, while the latter will have to be divided among several distinct families.

There are two genera of Silurian fossils unnoticed in the Table, which may eventually have to be included in the *Rhabdophora*. The genus *Corynoides* ought perhaps to be considered morphologically as a Graptolite, in which development never proceeds beyond the sicula stage. The polypary in *Thamnograptus* (Hall) appears to be furnished with a dorsal filament or solid axis, which enters into all the ramifications of the branches.

APPENDIX.

Description of new genera and species.

Sub. order: RHABDOPHORA (Allman).

Sect. I.—GRAPTOLITIDÆ.

Fam.: NEMAGRAPTIDÆ (Hopkinson).

LEPTOGRAPTUS (gen. nov.). (Gr. λεπτος, slender.)

Polypary consisting of two simple, slender, flexuous, monoprionidian branches, proceeding in opposite directions from the major extremity of a well-marked persistent sicula, which is sometimes developed into a third and central branch. Thecæ of the form of those of *Pleurograptus*. Radicle and lateral spines usually invisible.

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[1] There are so many natural and obvious reasons at present for regarding this term as synonymous with Allman's term *Rhabdophora*, that it might prove of service to employ the term *Graptoloidea* for this section, as a second and convertible designation.

Example—*Leptograptus flaccidus*, Hall sp.

Amphigraptus (gen. nov.). (Gr. ἀμφὶ, on both sides.)

Polypary consisting of two principal, compound, slender, monoprionidian branches, proceeding in opposite directions from the major extremity of a small, inconspicuous sicula. Secondary branches normally simple; given off from both margins of the principal branches, in the neighbourhood of the initial point, usually in pairs. Thecæ of the form of those of *Pleurograptus*. Radicle and lateral spines invisible.

Example—*Amphigr. divergens*, Hall sp.

Section II.—Retioloidea.

Fam.: Glossograptidæ.

Lasiograptus, gen. nov. (Gr. λάσιος—hairy, shaggy.)

Gen. char.—Polypary diprionidian, simple; with sub-parallel margins; section somewhat concavo-convex. Virgula slender, central. Periderm thickened. Thecæ somewhat resembling those of *Climacograptus*; separated by distinct and deep "excavations," and having their proximal walls strengthened by a pair of chitinous filaments, which converge at the margin, and are prolonged outwardly as a simple spinous process. This process gives origin to a series of slender filaments, which anastomose with those derived in a similar manner from the processes immediately above and below, and form a row of meshes almost surrounding the polypary. Lateral spurs rarely present.

Example—*Lasio. costatus*, sp. nov.—Polypary ½ to ¾ of an inch in length—margins converging towards both extremities; maximum width $\frac{1}{10}$ of an inch, or, inclusive of the extraneous meshes, $\frac{1}{5}$ of an inch. Virgula slightly prolonged distally: Thecæ inclined to the axis of the polypary at an angle of about 45°: outer walls little shorter than the interspaces: apertures apparently situated within the general boundary of the polypary.

Horiz.: Lower Moffat Shales (Lower Llandeilo), S. Scotland.

Fam.: Retiolitidæ.

Clathrograptus (Lat. *clathrum*—a lattice).

Gen. char.—Polypary diprionidian; simple; elongate elliptical in form, or with sub-parallel margins: section square. Periderm reduced to a mere film, which is usually invisible; supported on a skeleton framework of chitinous threads. Virgula an extremely minute longitudinal filament, forming a portion of the supporting framework. Thecæ inclined, of the general form of flattened rectangular prisms.

Example—*Clathrograptus cuneiformis*, sp. nov. Polypary cuneiform; from ¼ to ½ of an inch in length; attaining maximum width of $\frac{1}{10}$ of an inch at its distal end: proximal extremity pointed, destitute of ornamental processes. Virgula excessively slender. Thecæ 22 to 24 to the inch, making an angle of about 30° with the line of the virgula furnished with short, stiff, apertural spines.

The genera Nos. [illegible] of the Table have never been met with [illegible] and are as yet without [illegible]

NOTES.

[illegible]

[illegible] employed throughout this paper merely as a [illegible] for the small [illegible] is [illegible] Nevertheless, [illegible] exactly expresses [illegible] rather expressive [illegible] What that fact is supposed to be [illegible]

[illegible]

The [illegible] are made by the [illegible] of the [illegible] They are the ventral [illegible] The latter [illegible] I have therefore termed [illegible] angle" in the former portion of this paper. This [illegible] merely as a matter of convenience, in [illegible] angle" [illegible] of the axil [illegible]

[illegible] with the [illegible] H[illegible] I [illegible] and my [illegible] Prof. Allman's [illegible] M[illegible] of the T[illegible] H[illegible] I have [illegible] his [illegible] of this paper. I hope to be able to [illegible] full [illegible] when I have been afforded an opportunity of [illegible] his remarkable [illegible]

The [illegible] by the published views of Mr. Hopkinson and Professor Nicholson have been already alluded to. I have also to thank Professor Allman for the kindly expression of his opinions on some of the more doubtful points.

The Geological Distribution of the Graptolites will be treated of in a separate paper.

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[1] The [illegible] the mode of growth in *Phyllograptus*, p. 502, is probably an error, and should be deleted.

IV.—HISTORY OF THE NAMES CAMBRIAN AND SILURIAN IN GEOLOGY.

By Prof. T. STERRY HUNT, LL.D., F.R.S.

(*Concluded from p.* 510.)

3. *Cambrian and Silurian Rocks in North America* (*abridged*).[1]

IN accordance with our plan, we now proceed to sketch the history of the Lower Palæozoic rocks in North America. While European geologists were carrying out the researches which have been described in the first and second parts of this paper, American investigators were not idle. The geological studies of Eaton led the way to a systematic survey of the State of New York, the results of which have been the basis of most of the subsequent geological work in eastern North America, and which was begun by legislative enactment in 1836. The State was divided into four districts, the work of examining and finally reporting upon which was committed to as many geologists. The first or south-eastern district was undertaken by Mather, the second or north-eastern by Emmons, the third or central by Vanuxem, and the fourth or western by James Hall; the palæontology of the whole being left to Conrad, and the mineralogy to Beck. After various annual reports, the final results of the survey appeared in 1842. The whole series of fossiliferous rocks known, from the basal or Potsdam sandstone to the Coal-formation, was then described as the New York system.

At that time the published researches of British geologists furnished the means of comparison between the organic remains found in the rocks of New York, and those then known to exist in the Palæozoic strata of Great Britain. Prof. Hall was thus enabled, in his Geology of the Fourth District of New York, to declare, from the study of its fossils, that the New York system included the Devonian of Phillips, the Silurian of Murchison, and the Cambrian of Sedgwick; meaning by the latter the Upper Cambrian, or Bala group, which alone was then known to be fossiliferous. From the evidence then before him, he concluded that the Upper Cambrian was represented, in the New York system, by the whole of the rocks from the base of the Utica slate, downward, with the probable exception of the Potsdam sandstone; while he conceived, partly on lithological grounds, that the Utica and Hudson River groups represented the Llandeilo and Caradoc, or the Lower Silurian of Murchison.

Emmons meanwhile had examined in eastern New York and western New England a series of fossiliferous rocks, which, on lithological and stratigraphical grounds, he regarded as older than any in the New York system; a view which had been previously maintained by Eaton. Holding with Hall, that the lower members of the New York system were the equivalents of the Upper Cambrian of Sedgwick, he looked upon the fossiliferous rocks, which he placed beneath them, as the representatives of the Lower Cambrian.

Feeling satisfied that the sedimentary rocks which he had examined in eastern New York were distinct from those which he, with Hall, regarded as corresponding to the Bala group or Upper Cambrian (the Lower Silurian of Murchison), and probably equivalent to the inferior portions of Sedgwick's Cambrian, and supposing that the latter term was henceforth to be effaced from geology (as indeed was attempted shortly after in the copy of Sedgwick's map published in 1844 by the Geological Society), he devised for these rocks the name of the Taconic system. as synonymous with the Lower (and Middle) Cambrian of Sedgwick.

To Prof. Hall, after the completion of the survey, had been committed the task of studying and describing the organic remains of the State, and in 1847 appeared the first volume of his great work on the "Palæontology of New York." Since 1842 he had been enabled to examine more fully the organic remains of the lower rocks of the New York system, and to compare them with those of the old world; and in the Introduction to the volume just mentioned (page xix) he announced the important conclusion that the New York system itself contained an older fauna than the Upper Cambrian of Sedgwick. According to Hall, the organic forms of the Calciferous and Chazy formations had not yet been found in Europe, and our comparison with European fossiliferous rocks must commence with the Trenton group. He however excepted the Potsdam sandstone, which already, in 1842, he had conceived to be below the Upper Cambrian of Sedgwick, and now regarded as the probable equivalent of the Obolus or Ungulite grit of St. Petersburg. Thus Emmons, in 1842, asserted, on lithological and stratigraphical grounds, the existence, beneath the base of the New York system, of a lower and unconformable series of rocks, in which, in 1844, he announced the discovery of a distinctive fauna. Hall, on his part, asserted in 1842, and more fully in 1847, that the New York system itself held an older fauna than that hitherto known in the British rocks.

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[1] From the "Canadian Naturalist," new series, vol. vi. no. 4, p. 417.

It is not necessary to recall in this place the details of the long and unfortunate Taconic controversy, which I have recently discussed in my address before the American Association for the Advancement of Science, in August, 1871. It is however to be remarked that Hall, in common with all other American geologists, followed Henry D. Rogers in opposing the views of Emmons, whose Taconic system was supposed to represent either the whole or a part of the Champlain division of the New York system; which included, as is well known, all of the fossiliferous rocks up to the base of the Oneida conglomerate (and also this latter, according to Emmons); thus comprehending both the first and the second Palæozoic fauna; as shown in the Table on page 510.

So early as 1827 Dr. Bigsby, to whom North American geology owes so much, had given us (Trans. Geol. Soc., 2nd series, vol. i. p. 37) a careful description of the geology of Quebec and its vicinity. He there found resting directly upon the ancient gneiss, a nearly horizontal dark-coloured conchiferous limestone, having sometimes at its base a calcareous conglomerate, and well displayed on the north shore of the St. Lawrence at Montmorenci and Beauport. He distinguished moreover a third group of rocks, described by him as a "slaty series composed of shale and greywacke, occasionally passing into a brown limestone, and alternating with a calcareous conglomerate in beds, some of them charged with fossils . . . . derived from the conchiferous limestone." (This fossiliferous conglomerate contained also fragments of clay-slate.) From all these circumstances Bigsby concluded that the flat conchiferous limestones were older than the highly inclined greywacke series; which latter was described as forming the ridge on which Quebec stands, the north shore to Cape Rouge, the Island of Orleans, and the southern or Point-Levis shore of the St. Lawrence; where, besides Trilobites, and the fossils in the conglomerates, he noticed what he called vegetable impressions, supposed to be fucoids. These were the Graptolites which, nearly thirty years later, were studied, described, and figured for the Geological Survey of Canada by Prof. James Hall; who has shown that two of the species from this locality were described and figured under the name of fucoids by Ad. Brongniart, in 1828. (Geol. Surv. Canada, Decade ii. p. 60.) Bigsby, in 1827, conceived that the limestones of the north shore might belong to the Carboniferous period, and noted the existence of what were called small seams of coal in the greywacke series of the south shore, which substance I have since described in the Geology of Canada (page 525).

In 1842, the Geological Survey of Canada was begun by Sir William Logan, who, in a preliminary report to the Government in that year (p. 19), says, "Of the relative age of the contorted rocks of Point Levis, opposite Quebec, I have not any good evidence, though I am inclined to the opinion that they come out from below the flat limestones of the St. Lawrence." He however subsequently adds, in a footnote, "The accumulation of evidence points to the conclusion that the Point Levis rocks are superior to the St. Lawrence limestones." [The views of Bayfield are here discussed, also the later observations of Logan.]

The concurrent evidence deduced from stratigraphy, from geographical distribution, from lithological and from palæontological characters, thus led Logan, from the first, to adopt the views expressed by Bigsby, Emmons and Bayfield, and to assign the whole of the Palæozoic rocks of the south-east shore of the St. Lawrence, below Montreal, to a position in the New York system above the Trenton limestone. While thus, as he says, founding his opinion on the stratigraphical evidence obtained in Eastern Canada, Logan was also influenced by the consideration that the rocks in question were continuous with those in western Vermont. Part of the rocks of this region had, as we have seen, originally been placed by Emmons at this horizon; while the others, referred by him to his Taconic system, were maintained by Henry D. Rogers to belong to the Hudson-River group; a view which was adopted by Mather and by Hall, and strongly defended by Adams, at that time engaged in a Geological Survey of Vermont, with which, in 1846 and 1847, the present writer was connected. [The subsequent palæontological discoveries are here discussed.]

Sir William Logan meanwhile made a careful stratigraphical examination of the rocks of Point Levis, and notwithstanding the peculiarities of the limestones which there contain the primordial fauna, declared himself, in December, 1860, satisfied that "the fossils are of the age of the strata." In consequence of the discovery of Mr. Billings, Logan now proposed to separate from the Hudson-River group the Greywacke series of Bigsby and Bayfield, and ascribed to it a much greater antiquity; regarding it as "a great development of strata about the horizon of the Chazy and Calciferous, brought to the surface by an overturn anticlinal fold, with a crack and a great dislocation running along the summit," by which the rocks in question were "brought to overlap the Hudson-River formation." This series, to which was assigned a thickness of from 5000 to 7000 feet, he named the Quebec group, which included the green sandstones of Sillery, regarded as the summit, the fossiliferous limestones and graptolitic shales at the base, which afterwards received the name of the Levis formation, and a great intermediate mass of barren shales and sandstones, called the Lauzon formation.

This important distinction once established, it was found necessary to draw a line from the St. Lawrence, near Quebec, to the vicinity of Lake Champlain, separating the true Hudson-River group, with its overlying Oneida or Medina rocks, on the north-west side, from the so-called Quebec group, on the south and east.

As early as 1842, Prof. Hall, in a comparison of the Lower Palæozoic rocks of New York with those of Great Britain, declared the Potsdam to be lower than the base of the Upper Cambrian or Bala group of Sedgwick. In 1847, as we have seen, he extended this observation to the Calciferous and Chazy, both of which he placed below this horizon; which until a year or two previous had been looked upon as the base of the Palæozoic series in Great Britain, and was subsequently made the lower limit of the second fauna of Barrande. Although from these facts it was probable that these lower members of the New York system might correspond to the primordial fauna of Barrande, we still remained, in the language of Prof. Hall, without "the means of parallelizing our formations with those of Bohemia, by the fauna there known. The nearest approach to the type of the Primordial Trilobites was found in the Potsdam of the north-west, described by Dr. D. D. Owen; but none of these had been generically identified with Bohemian forms, and the prevailing opinion, sanctioned, as I have understood, by M. Barrande, was that the primordial fauna had not been discovered in this country until the re-discovery (in 1856) of *Paradoxides Harlani* at Braintree, Mass. [The history of this *Paradoxides* is then related.]

The geological examinations of Mr. Alexander Murray in Newfoundland since 1865 have shown that the south-eastern part of that island contains a great volume of Cambrian rocks, estimated by him at about 6000 feet in all. No traces of the Upper Cambrian or second fauna have been detected among these, but some portions contain the *Paradoxides* already mentioned, while others yield the fauna which Mr. Billings has called Lower Potsdam. This name was first given in an appendix (prepared by Sir W. E. Logan) to Mr. Murray's report on Newfoundland for 1865, published in 1866 (page 46; see also Report of the Geol. Survey of Canada for 1866, p. 236). The Lower Potsdam was there assigned a place above the *Paradoxides* beds of the region, which were called the St. John group,—the fossiliferous strata of St. John, New Brunswick, being referred to the same horizon; which corresponds to the Menevian of Wales, now recognized as the summit of the Lower Cambrian. The succession of the rocks containing these two faunas in south-eastern Newfoundland is not yet clear; the Lower Potsdam fauna is regarded by Mr. Billings as identical with that found on the strait of Bellisle, at Bic (on the south shore of the river St. Lawrence, below Quebec), at Georgia, Vermont, and at Troy, New York; but in none of these other localities is it as yet known to be accompanied by a Menevian fauna. The Trilobites hitherto described from these rocks belong to the genera *Olenellus*, *Conocoryphe*, and *Agnostus*; neither *Paradoxides*, which characterizes the Menevian and the underlying Harlech beds in Wales, nor *Olenus*, which there abounds in the rocks immediately above this horizon, having as yet been described as occurring in the

Lower Potsdam of Mr. Billings. Future discoveries may perhaps assign it a place below instead of above the Menevian horizon.

The characteristic Menevian fauna in and near St. John, New Brunswick, is found in a band of about 150 feet, towards the base of a series of nearly vertical sandstones and argillites, underlaid by conglomerates, and resting upon crystalline schists, in a narrow basin. The series, the total thickness of which is estimated by Messrs. Matthew and Bailey at over 2000 feet, contains *Lingula* throughout, but has yielded no remains of a higher fauna. The same Menevian forms have been found in small outlying areas of similar rocks, at two or three places north of the St. John basin, but to the south of the New Brunswick coal-field. To the north of this is a broad belt of similar argillites and sandstones, which extends south-westward into the State of Maine. This belt has hitherto yielded no organic remains, but is compared by Mr. Matthew to the Cambrian rocks of the St. John basin, and to the gold-bearing series of Nova Scotia (Geol. Journ. vol. xxi. p. 427), which at the same time resembles closely the Cambrian rocks of south-eastern Newfoundland. This was remarked by Dr. Dawson in 1860, when he expressed the opinion that the auriferous rocks of Nova Scotia were "the continuation of the older slate series of Mr. Jukes in Newfoundland, which has afforded *Paradoxides*," and probably the equivalent of the Lingula-flags of Wales. (Supplement to Acadian Geology (1860), page 53; also Acad. Geol. 2nd ed. p. 613.) Associated with these gold-bearing strata, along the Atlantic coast of Nova Scotia, occur fine-grained gneisses, and mica-schists with andalusite and staurolite; besides other crystalline schists, which are chloritic and dioritic, and contain crystallized epidote, magnetite and menaccanite. These two types of crystalline schists (which, from their stratigraphical relations, as well as from their mineral condition, appear to be more ancient than the uncrystalline gold-bearing strata) were in 1860, as now, regarded by me as the equivalents respectively of the White Mountain and Green Mountain series of the Appalachians; as will be seen by reference to Dr. Dawson's work just quoted. At that time, however, and for many years after, I held, in common with most American geologists, the opinion that these two groups of crystalline schists were altered rocks of a more recent date than that assigned to the auriferous series of Nova Scotia by Dr. Dawson; who was much perplexed by the difficulty of reconciling this view with his own. The difficulty is however at once removed when we admit, as I have maintained for the last two years, that both of these groups are pre-Cambrian in age. (Amer. Jour. Sci. ii. l. 83; address to the Amer. Asso. Adv. Sci. August, 1871.)

A notice by Mr. Selwyn of some of these crystalline schists in Nova Scotia will be found in the report of the Geological Survey of Canada for 1870. He there remarks, moreover, the close lithological resemblances of the gold-bearing strata to the Harlech grits and Lingula-flags of North Wales, and announces the discovery among these strata of peculiar organic markings regarded by Mr. Billings as identical with the *Eophyton Linnæanum*, which is found at the base of the Cambrian in Sweden.

[The palæontological features of the rocks are then referred to more particularly, and the marked break that occurs between the Levis and Trenton faunas.]

The history of the introduction of the names of Silurian and Devonian into North American geology demands our notice. Prof. Hall, while recognizing in the rocks of the New York system the representatives alike of the British Cambrian, Silurian and Devonian, wisely refrained from adopting this nomenclature, drawn from a region where wide diversities of opinion and controversies existed as to the value and significance of these divisions. Lyell, however, in the account of his first journey to the United States, published in 1845, applied the terms Lower and Upper Silurian and Devonian to our Palæozoic rocks. Later, in 1846, de Verneuil, the friend and colleague of Murchison in his Russian researches, visited the United States, and on his return to France published, in 1847,[1] an elaborate comparison between the European Palæozoic deposits and those of North America, as made known by Hall and others. He proposed to group the whole of the rocks of the New York system, up to the summit of the Hudson-River group, in the Lower Silurian, and the succeeding members, including the Lower Helderberg, and the overlying Oriskany, in the Upper Silurian; the remaining formations to the base of the Carboniferous system being called Devonian.

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[1] Bull. Soc. Geol. de Fr. II. iv. p. 646.

This essay by de Verneuil was translated and abridged by Prof. Hall, and published by him in the American Journal of Science, with critical remarks, wherein he objected to the application of this disputed nomenclature to North American geology.

Meanwhile the Geological Survey of Canada was in progress under Logan, who, in his preliminary report in 1842, and in his subsequent ones for 1844 and 1846, adopted the nomenclature of the New York system, without reference to European divisions. Subsequently however, the usage of Lyell and de Verneuil was adopted by Logan, who, in his report for 1848 (page 57), spoke of the Clinton group as the base of the "Upper Silurian series," while in that for 1850 (page 34) he declared the whole of a great series of fossiliferous rocks in Eastern Canada, including the Trenton, Utica, and Hudson-River divisions, and the shales and sandstones of Quebec (then supposed to be superior to these) to "belong to the Lower Silurian." In the report for 1852 (page 64) the Lower Silurian was made by Mr. Murray to include not only the Utica and Trenton, but the Chazy limestone, the Calciferous sandrock and the Potsdam sandstone of the New York system. From this time the Silurian nomenclature, as applied by Lyell and de Verneuil to our North American rocks, was employed by the officers of the Canadian Geological Survey (myself among the others), and was subsequently adopted by Prof. Dana in his Manual of Geology, published in 1863.

The Geological Survey of Pennsylvania, under the direction of Prof. Henry Darwin Rogers, was begun, like that of New York, in 1836, and the Palæozoic rocks of the State were at first divided, on stratigraphical and lithological grounds, into groups, which were designated, in ascending order, by Roman numerals. Subsequently, as he informs us in the preface to his final Report on the Geology of Pennsylvania, Prof. H. D. Rogers, in concert with his brother, Prof. William B. Rogers, then directing the Geological Survey of Virginia, considered the question of geological nomenclature. Rejecting, after mature deliberation, the classification and nomenclature both of the British and New York Geological Surveys, they proposed a new one for the whole Palæozoic column to the top of the Coal-measures, founded on the conception of a great Palæozoic day, the divisions of which were designated by names taken from the sun's apparent course through the heavens. (Geology of Penn., I. vi. 105.) So far as regards the three great groups which we have recognized in the Lower Palæozoic rocks, the later names of Rogers, and his earlier numerical designations, with their equivalents in the New York system, were as follows:

Primal (I.). This includes the mass of 2500 feet or more of shales and sandstones, which in Pennsylvania and Virginia, and farther southwards, form the base of the Palæozoic series, and rest upon crystalline schists. The Primal division was regarded by the Messrs. Rogers as the equivalent both of the Potsdam and the still lower members of the Cambrian.

Auroral (II.). This division, which, with the last, includes the first fauna, consists in great part of magnesian limestones, and corresponds to the Calciferous and Chazy formations. Its thickness in Pennsylvania varies from 2500 to 5000 feet, and with the preceding division, it includes the first fauna. The representatives of the Primal and Auroral divisions attain a great development in Eastern Tennessee, where they have been studied by Safford.

Matinal (III.). In this, which represents the second fauna, were comprised the limestones of the Trenton group, together with the Utica and Hudson-River shales.

Levant (IV.). This division corresponds to the Oneida and Medina conglomerates and sandstones.

Surgent, *Scalent* and *Pre-Meridional* (V., VI.). In these divisions were included the representatives of the Clinton, Niagara, and Lower Helderberg groups of New York, making, with Division IV., the third fauna.

The parallelism of these divisions with the British rocks was most clearly and correctly pointed out by H. D. Rogers himself, in an explanation prepared, as I am informed, with the collaboration of Prof. William B. Rogers, and published in 1856, with a geological map of North America by the former, in the second edition of Keith Johnston's Physical Atlas. The Palæozoic rocks of North America are there divided into several groups, of which the first, including the Primal, Auroral, and Matinal, is declared to be the near representative of "the European Palæozoic deposits from the first-formed fossiliferous beds to the close of the Bala group; *that is to say, the proximate* representatives of the Cambrian of Sedgwick." A second group embraces the Levant, Surgent, Scalent, and Pre-Meridional. These are said to be "the very near representatives of the true European Silurian, regarding this series as commencing with the May-Hill sandstone." The Levant division is farther declared to be the equivalent of the sandstone just named; while the Matinal is made to correspond to the Landeilo, Bala, or Upper Cambrian; the Auroral with the Ffestiniog or Middle Cambrian; and the Primal with the Lingula-flags, the Obolus sandstone of Russia, and the Primordial of Bohemia.

The range of Silurian should therefore be restricted, as maintained by Sedgwick and by the Messrs. Rogers, to the rocks of the third fauna: the so-called Upper Silurian of Murchison; and the names of Middle Silurian, Lower Silurian, and Primordial Silurian banished from our nomenclature. The Cambrian of Sedgwick, however, includes the rocks both of the first and second faunas. To the former of these, the lower and middle divisions of the Cambrian (the Bangor and Ffestiniog groups of Sedgwick), Phillips, Lyell, Davidson, Harkness, Hicks, and other British geologists, agree in applying the name of Cambrian. The great Bala group of Sedgwick, which constitutes his Upper Cambrian, is, however, as distinct from the last as it is from the overlying Silurian, and deserves a not less distinctive name than these two. Its original designation of Upper Cambrian, given when the zoological importance of Lower and Middle Cambrian was as yet unknown, is not sufficiently characteristic; and the same is to be said of the name of Lower Silurian, wrongly imposed upon it. The importance of this great Bala group in Britain, and of its North American equivalent, the Matinal of Rogers,—including the whole of the limestones of the Trenton group, with the succeeding Utica and Hudson-River shales,—might justify the invention of a new and special name. That of Cambro-Silurian, at one time proposed by Sedgwick himself, and adopted by Phillips and by Jukes, was subsequently withdrawn by him, when investigations made it clear that this group had been wrongly united with the Silurian by Murchison. Deference to Sedgwick should therefore prevent us from restoring this name, which, moreover, from its composition, connects the group rather with the Silurian than the Cambrian. Neither of these objections can be urged against the similarly-constructed term of Siluro-Cambrian, which moreover has the advantage that no other new name could possess, of connecting the group both with the true Silurian, to which it has very generally been united, and with the Cambrian, of which, from the first, it has formed a part. I therefore venture to suggest the name of Siluro-Cambrian, as a convenient synonym for the Upper Cambrian of Sedgwick (the Lower Silurian of Murchison), corresponding to the second fauna; reserving at the same time the name of Cambrian for the rocks of the first fauna,—the Lower and Middle Cambrian of Sedgwick,—and restricting with him the name of Silurian to the rocks of the third fauna,—the Upper Silurian of Murchison.

It would be unjust to conclude this historical sketch of the names Cambrian and Silurian in Geology, without a passing tribute to the venerable Sedgwick. The labours of his successors in the study of British geology, up to the present time, have only served to confirm the exactitude of his early stratigraphical determinations; and the last results of investigations on both continents unite in showing that in the Cambrian series, as defined by him more than a generation since, he laid, on a sure foundation, the bases of Palæozoic geology.

NOTICES OF MEMOIRS.

I.—CARDIFF NATURALISTS' SOCIETY: REPORTS AND TRANSACTIONS. Vol. III., Parts 1 and 2, for 1870-71 (1872), and Vol. IV. for 1872 (1873).

AMONG a great deal of general information on Natural History and scientific subjects, together with special descriptions of local points of interest, in which antiquary, botanist and geologist are concerned, and a monthly series of valuable meteorological reports by Mr. F. G. Evans, backed by tables of observations, we find in these Transactions an elaborate and exhaustive memoir on the Rhætic Beds of Penarth and Lavernock, by Mr. Etheridge, F.R.S., vol. iii. part 2, pp. 39, etc., with two plates of fossils, and two of sections.

II.—On the Species of *Favosites* from the Devonian Rocks of Western Ontario.[1] By Prof. H. Alleyne Nicholson, M.D., D.Sc., etc., etc.

THIS paper is intended by Prof. Nicholson to supplement one by Mr. Billings on the Devonian Corals of Canada West (Canadian Journal, new series, vol. iv. p. 97), with some of whose conclusions, as to the species of *Favosites*, Prof. Nicholson is unable to agree.

The genus *Favosites*, Lam., comprises branched or massive corals, composed of numerous more or less polygonal corallites, divided internally by transverse septa or "tabulæ," sometimes quite rudimentary. The walls of the corallites are perforated by one, two, three, or more rows of mural pores. The septa are absent or rudimentary, being at most represented by tubercles or short spines.

Palæontologists are not agreed as to the generic limits of *Favosites*, and several new genera have been founded, which Prof. Nicholson gives reasons for rejecting.

The numerous species of *Favosites* may be divided into two groups—massive and ramose; *F. Gothlandica* being the type of the former, and *F. polymorpha* of the latter.

The following characters have been relied on for separating the species of this genus:—1. The diameter of the corallites; 2. The equality or inequality of their size; 3. The completeness or incompleteness of the tabulæ; 4. The number of rows of mural pores; 5. The position of the mural pores; 6. The presence or absence of rudimentary septa.

For convenience of reference, the author gives the following table of the more important species of *Favosites*, it being remembered that some of them are perhaps not valid, and the number of rows of mural pores not constant even in the limits of the same species.

A. Massive species.

a. Tabulæ complete. One row of mural pores, placed on the faces of the corallites.

1. *Favosites basaltica*, Goldf.
2. *Favosites turbinata*, Billings.

b. Tabulæ complete. Two rows of mural pores, placed on the faces of the corallites.

3. *Favosites Gothlandica*, Lam.
4. *Favosites Niagarensis*, Hall.

c. Tabulæ complete. Three rows of mural pores, placed on the faces of the corallites.

5. *Favosites multipora*, Lonsd.
6. *Favosites Troosti*, Edw. and Haime.

d. Tabulæ complete. Mural pores situated in the angles formed by the prismatic walls of the corallites.

7. *Favosites alveolaris*, Goldf.
8. *Favosites aspera*, Goldf.

e. Tabulæ more or less incomplete. Mural pores in one, or more commonly two rows.

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[1] From "The Canadian Journal."

9. *Favosites hemispherica*, Yandell and Shumard.
10. *Favosites Forbesi*, Edw. and H.

B. Ramose species.
- *a.* With one row of mural pores, on the faces of the corallites.
  - 11. *Favosites polymorpha*, Goldf.
  - 12. *Favosites cervicornis*, De Blainville.
  - 13. *Favosites reticulata*, De Blainville.
- *b.* With one row of pores, placed in the angles formed by the prismatic faces of the corallites.
  - 14. *Favosites fibrosa*, Goldf.

Of the above species, those which have been recognized as occurring in the Devonian rocks of Canada are: *Favosites Gothlandica*, Lam.; *F. hemispherica*, Yandell and Shumard; *F. Forbesi*, Edw. and H.; *F. turbinata*, Billings; *F. cervicornis*, De Blainville; and *F. polymorpha*, Goldf.

I. *Favosites Gothlandica*, Lamarck.—"Corallum forming spheroidal, pyriform, or large hemispheric or flattened masses; corallites are in general between one and one a half lines wide, sometimes more, sometimes less, often two lines; transverse diaphragms usually complete, rarely incomplete; mural pores in one, two, or three series, usually two, those of the same series about half a line distant, sometimes less; pores surrounded by an elevated margin; faces of the tubes with one or two longitudinal striæ, more or less distinctly developed; radiating septa represented by a series of small spines, often in the rudimentary form of tubercles."—Billings.

Whilst the above exist in typical specimens, there are numerous departures from this state of things. The corallites are often uniformly below the average in an entire colony, or nearly round instead of polygonal. There is sometimes but one, and sometimes three rows of mural pores. The tabulæ are sometimes absent, and sometimes form little projecting lamellæ, or ridges, sometimes resembling those of *F. hemispherica*, being closely set and incomplete, often more or less bent, and commonly interlocking.

The septa as a general rule are absent, or at any rate indeterminable, but are, however, not uncommonly to be recognized in the form of small inequalities or minute tubercles.

The shape of the colonies also varies much. The colony is based on a concentrically wrinkled epitheca, which is very commonly wanting in decorticular specimens, and attains a considerable thickness in aged examples.

Locality and Formation—Common throughout the Corniferous Limestone in Canada West.

II. *Favosites basaltica*, Goldfuss.—It is with regard to this species that Prof. Nicholson is inclined to differ from the conclusions arrived at by Mr. Billings.

Making a single row of mural pores the distinguishing character of this species, Goldfuss includes under this head—

1. Specimens which differ only in this respect from *F. Gothlandica.*

2. Specimens which agree with the preceding in having some-

times (not always) a single row of mural pores, but which differ in having nearly rounded or cylindrical corallites of very unequal size, whilst the tabulæ are only represented by short projecting lamellæ, imparting a peculiar and characteristic appearance to the inner surface of the corallites.

It is the first of these groups which is usually regarded as the type-form of *F. basaltica*, Goldf.; and the only question is whether these are separable from *F. Gothlandica*, Lam., or not. The author next discusses the opinions of various writers on this point.

The second group was separated by MM. Milne-Edwards and Haime from the first under the head of *F. Forbesi;* but Mr. Billings re-united them under the former name of *F. basaltica*, Goldf.

Prof. Nicholson considers that *F. Forbesi*, M.-Ed. and H., is a good species, and proceeds to describe it.

III. *Favosites Forbesi*, Edw. and H.—Corallum forming spheroidal, pyriform, cylindroidal, or depressed hemispheric masses, composed of corallites, generally circular or cylindrical in shape, and usually very unequal in size; mural pores in two alternating rows, rarely in a single row; tabulæ mostly rudimentary and represented by very close-set projecting lamellæ, which roughen the interior of the corallites; radiating septa represented, sometimes clearly, sometimes indistinctly, by a number of longitudinal ridges or striæ.

The corallites are large and small, each larger one being surrounded by an incomplete ring of smaller, which vary considerably in size, whilst the larger are pretty constant; the mural pores often cannot be made out. The tabulæ are present in an incomplete and rudimentary form, projecting a short way into the corallite, giving it a peculiar and easily-recognized appearance, and in one specimen in Prof. Nicholson's possession extend half across the corallite, often bifurcating or interlocking at their free ends, and sometimes extending right across. The radiating septa are quite rudimentary, and when discernible have the form of obscurely marked longitudinal striæ. Lastly, the author has observed in some specimens, especially those of a cylindroidal or clavate form, the peculiar feature that the calices of a greater or less moiety of the colony are closed by an epitheca, closely resembling what is observed in *F. turbinata*, Billings.

Prof. Nicholson next mentions some other specimens which present several peculiar features, but which he cannot at present separate from this species.

Locality and Formation—Corniferous Limestone, Port Colborne, and lot 6, con. 1, Wainfleet.

IV. *Favosites hemispherica*, Yandell and Shumard.—In its essenial characters this species is closely allied to *F. Gothlandica;* but the corallites are much smaller in size and the tabulæ incomplete, very thin, and closely set, usually extending only half-way across the corallite, and often interlocked towards its centre. Usually, however, some of the tabulæ are complete. The mural pores are stated o be in one, two, or three rows (M.-Edw. and H. and Billings), but he author has not detected any in the Canadian specimens which he has seen. According to Milne-Edwards and Haime, also, there are twelve well-developed septa, but these are indeterminable in the Canadian specimens. The author agrees with Mr. Billings in thinking that this species may turn out to be identical with *F. Gothlandica*, and in refusing to adopt the genus *Emmonsia* proposed for this species by M.-Edw. and Haime.

Locality and Formation—Common in the Corniferous Limestone of Ridgway, Port Colborne, and many other places in Western Ontario.

V. *Favosites turbinata*, Billings.—"Corallum forming elongate turbinate masses, sometimes two feet in length and six inches in diameter, often curved at the base. Corallites nearly uniform in size, usually somewhat less than a line in width; transverse diaphragms thin, flat, flexuous, complete or incomplete. Only one row of pores has been observed. Whole surface, except the upper part, covered with a strong epitheca, which closes the mouth of the cells."—Billings.

The form of the colony varies much, sometimes being merely an irregularly curved mass, which looks like a large potato.

The epitheca in most specimens is smooth and sufficiently thin to allow of the form of the corallites being traced through it. In a large number of specimens it has been denuded or decorticated.

The corallites radiate from the imaginary axis of the colony either in straight lines or curves, and in shape are rounded, subprismatic, or more commonly distinctly prismatic. They are by no means uniform in size, there being generally a considerable number of undersized corallites intercalated amongst the nearly equal-sized larger tubes.

The mural pores, so far as the author has observed, are uniformly in single rows, placed on the flat surfaces of the corallites, and from half a line to a line apart.

Locality and Formation —Common in the Corniferous Limestone of Ridgway, Port Colborne, and other localities in Western Ontario.

VI. *Favosites polymorpha*, Goldfuss.—Corallum dendroid, often dichotomously branched, or reticulated; diameter of branches varying from a little over a line to more than an inch. Corallites radiating in all directions from an imaginary axis nearly at right angles, more or less contracted internally, and widening as they approach the surface. Diameter of corallites from half to three-quarters of a line in branches of half an inch across, often with smaller ones intercalated. Calices in reality polygonal, but usually rendered circular by the thickening of their walls. Mural pores in a single series.

The ramose species of *Favosites* are so variable in their characters, that Prof. Nicholson intends to treat of them hereafter along with the species of *Alveolites*, to which they present many superficial resemblances.

The above definition includes the typical forms of *F. polymorpha*, but there are numerous examples which can be regarded either as mere varieties of it or as belonging to another species altogether. Such, for example, as *F. cervicornis* and *F. dubia*, De Blainville.

Besides the above, the Devonian rocks of Western Ontario yield at any rate one ramose form of *Favosites*, which appears to be distinct from any as yet described.—B. B. W.

REPORTS AND PROCEEDINGS.

GEOLOGICAL SOCIETY OF LONDON.—OPENING MEETING, November 5, 1873. Professor Ramsay, F.R.S., Vice-President, in the Chair. The following communications were read:—

1. "On the Skull of a species of *Halitherium* from the Red Crag of Suffolk." By Prof. W. H. Flower, F.R.S., F.G.S.

The specimen described, which is in the collection of the Rev. H. Canham, of Waldringfield, is from the so-called coprolite- or bone-bed at the base of the Red Crag, and presents the usual aspect of the mammalian remains from that bed. It is of especial interest as furnishing the first recorded evidence of the existence in Britain of animals belonging to the order Sirenia. The fragment consists of the facial part of the cranium, separated, probably before fossilization, from the posterior part of the fronto-parietal suture, and in a line descending vertically therefrom. It was afterwards subjected to severe attrition, by which many of the projecting parts have been removed, but sufficient remains to enable its general relationship to known forms to be determined. The whole of that portion of the maxillæ in which the molar teeth were implanted is preserved.

The author compared the fossil skull with those of the existing and extinct species of the order, and stated that while it presents many characters common to the Manati and the Dugong, there are others by which it differs from both, the most striking being the more normal development of the nasal bones and the outer wall of the nasal fossæ, and especially the dentition, in all of which it shows a more generalized condition. The existence in it of maxillary teeth removes it still further from *Rhytina*. In general character the molars correspond with those of the genus *Halitherium*, in which the author considered that this fossil found its nearest ally in *H. Schinzi*, Kaup, from the Miocene of the Rhine Valley, a formation in which several of the animals of the Red Crag bone-bed are known to occur. The differences, however, especially the larger size of the cranium, in the Crag specimen, and the larger size of its teeth, induce the author to regard it as a distinct species, which he proposes to name *Halitherium Canhami*.

Discussion.—Mr. Prestwich thought the specimen a most interesting addition to the derived fossils of the lower beds of the Red Crag. It was most likely derived from some of the Miocene beds which formerly existed, probably on what is now the basin of the German Ocean.

Mr. H. Woodward mentioned that in the Woodwardian Collection there was a skull of *Halitherium* from the Miocene of Darmstadt. It was, he thought, of great interest to meet with these Miocene forms in the Crag, most of the fossils of which appear to have been derived from the lower beds of the London Clay.

Dr. Leith Adams mentioned the discovery of a tooth of *Halitherium* in a calcareous bed in Malta, where also he had discovered one of the ear-bones.

Mr. Seeley pointed out that the skull presented some peculiarities, which made him doubt whether it could rightly be ascribed to *Halitherium*. He thought possibly it might belong to a new genus; at the same time he had noticed in the Crag deposits some vertebræ which he thought might be attributed to *Halitherium*.

The Chairman was glad to find that so many geologists were disposed to regard the majority of the fossil bones from the Crag as derivative. He had long regarded them as belonging to a Miocene period, and probably a late one, and to a time when this country was united to the continent. When at the Crag period a portion of the surface was submerged, the neighbouring land might, however, have been still inhabited by the old Miocene fauna.

2. "New Facts bearing on the Inquiry concerning Forms intermediate between Birds and Reptiles." By Henry Woodward, F.R.S., F.G.S.

The author, after giving a brief sketch of the Sauropsida, and referring especially to those points in which the Pterosaurians approach and differ from birds, spoke of the fossil birds and land reptiles which he considered to link together more closely the Sauropsida as a class.

The most remarkable recent discoveries of fossil birds are:—

I. *Archæopteryx macrura* (Owen), a Mesozoic type, which has a peculiar reptilian-like tail, composed of twenty free and apparently unanchylosed cylindrical vertebræ, each supporting a pair of quill-feathers, the last fifteen vertebræ having no transverse processes, and tapering gradually to the end.

II. *Ichthyornis dispar* (Marsh), discovered by Prof. O. C. Marsh in 1872 in the Upper Cretaceous beds of Kansas, U.S. It possessed well-developed teeth in both jaws. The teeth are set in distinct sockets, and are more or less inclined backwards.

III. *Odontopteryx toliapicus* (Owen), an Eocene bird from the London Clay of Sheppey, the skull of which alone has been discovered, has very prominent denticulations of the alveolar margins of the jaws.

The author then referred to the Dinosauria, some of which he considered to present points of structure tending towards the so-called wingless birds.

I. *Compsognathus longipes* (A. Wagner), from the Oolite of Solenhofen, is about two feet in length, having a small head with toothed jaws, supported on a long and slender neck.

The iliac bones are prolonged in front of and behind the acetabulum; the pubes are long and slender. The bones of the fore limbs are small, and were probably furnished with two clawed digits. The hind limb is very large, and disposed as in birds, the femur being shorter than the tibia. The proximal division of the tarsus is anchylosed with the tibia as in birds.

II. The large carnivorous *Megalosaurus*, ranging from the Lias to the Wealden, had strong but not massive hind limbs, and short reduced fore limbs; it moved with free steps, chiefly if not solely on its hind limbs, which is true also of the vegetable-feeding lizards of the Mesozoic rocks.

The author next drew attention to the Frilled Lizard of Australia (*Chlamydosaurus Kingii*, Gray), which has its fore limbs very much smaller than the hind limbs, and has been observed not only to sit up occasionally, but to run habitually upon the ground on its hind legs, its fore paws not touching the earth, which upright carriage necessitates special modifications of the sacrum and pelvic bones.

The Solenhofen Limestone, in which Pterosauria are frequent, and which has yielded the remains of *Archæopteryx* and of *Compsognathus*, has also furnished a slab bearing a bipedal track, resembling what might be produced by *Chlamydosaurus* or *Compsognathus*. It shows a median track formed by the tail in being drawn along the ground; on each side of this the hind feet with outspread toes leave their mark, while the fore feet just touch the ground, leaving dot-like impressions nearer the median line. Hence the author thought that while some of the bipedal tracks which are met with from the Trias upwards may be the "spoor" of Struthious birds, most of them are due to the bipedal progression of the Secondary Reptiles.

Discussion.—Mr. Seeley thought that the footprints on the slab cited in the paper had been produced by some saurian, such as a Pterodactyle, the fore limbs of which were wider apart than its hind limbs, rather than by *Compsognathus*. If the foot-track had been due to a saurian walking on its hind legs only, he thought that the principal impressions must of necessity have been nearer together. He disputed the correctness of the term "adaptive modification" as applied to the air-cavities in bones. He was inclined to regard the Pterodactyle as more closely allied to Birds than did the author of the paper. The condition of the carpus, as well as the tarsus, in these reptiles showed their ornithic affinities. He cited jerboas, kangaroos, and other forms, in which the hind legs were mainly used for progression, but in which the sacrum and other bones were not modified, as instances calculated to inspire caution in connecting the mode of progression with structure.

Mr. Hulke could not regard the tracks as those of a Pterodactyle, as the inner marks were much less distinct than the outer, and would therefore hardly be due to the hinder limbs, on which the weight would mainly fall.

Mr. Blanford agreed with Mr. Seeley that the mere fact of the *Chlamydosaurus* walking on its hind legs did not suffice to prove any affinity with Dinosaurians.

Mr. Woodward, in reply, stated that the two points on which he had mainly founded the paper were:—1st, the occurrence of footprints in the Solenhofen limestone, characteristic of a bipedal progression of some saurian, which had, moreover, used its tail from time to time to give it a forward impetus; and 2ndly, the method of walking of *Chlamydosaurus*. With regard to animals thus progressing, he was not prepared to accept the view that there was no corresponding modification in structure.

3. "Note on the Astragalus of *Iguanodon Mantelli*." By J. W. Hulke, Esq., F.R.S., F.G.S.

The author exhibited and described an astragalus of *Iguanodon* from the collection of E. P. Wilkins, Esq., F.G.S. The bone was believed to be previously unknown. It is a bone of irregular form, having on its lower surface the characteristic pulley-shape of a movable hinge-joint. The upper surface presents a form exactly adapted to that of the distal end of the tibia, so that the applied surfaces of the astragalus and tibia must have interlocked in such a manner as to have precluded all motion between them. The author remarked upon the interest attaching to this fact in connexion with the question of the relationship between the Dinosauria and Birds.

4. "Note on a very large Saurian Limb-bone, adapted for progression upon land, from the Kimmeridge Clay of Weymouth, Dorset." By J. W. Hulke, Esq., F.R.S., F.G.S.

The bone described by the author presents a closer resemblance to the Crocodilian type of humerus than to any other bone, and he regarded it as the left humerus of the animal to which it belonged. Its present length is 54 inches, but when perfect it could hardly have been less than 63 inches in length. The middle of the shaft is cylindroid. Its transverse section is of a subtrigonal figure, and presents a large coarsely cancellated core, inclosed in a compact cortical ring. The bone is considerably expanded towards the two extremities; the distal articular surface is oblong, and divided into a pair of condyles by a very shallow vertical groove; below, the anterior border, in its proximal half, is much wider than the corresponding portion of the posterior border, and is flattened and produced downwards into a ventrally projecting crest; and the distal half of this border forms a thin, rough crest, projecting forwards. The presence of these crests distinguishes the present humerus from those of *Pelorosaurus* and of *Ceteosaurus Oxoniensis;* but the general correspondence of the bone with the humerus of the latter species leads the author to refer it provisionally to a species of *Ceteosaurus*, which he proposes to name *C. humero-cristatus.*

Discussion.—Mr. Seeley remarked that the internal structure of the bone resembled that found in *Gigantosaurus*, and the general form of the humerus was such as might be expected did it belong to an animal of that genus.

5. A despatch from Mr. Alfred Biliotti, British Vice-Consul at Rhodes (dated June 16, 1873), communicated by H. M. Secretary of State for Foreign Affairs, and relating to the volcanic outburst in the island of Nissiros, one of the Sporades, in which there existed a volcano supposed to be extinct. Shortly before the 10th June new craters opened in this volcano, and from them ashes, stones, and lava were ejected; many fissures, from which hot water flowed, were produced in the mountain, and the island was daily shaken by violent earthquakes. From Rhodes, at a distance of about 50 miles, the smoke rising from the new craters could be seen.

CORRESPONDENCE.

THE CHESIL BANK.

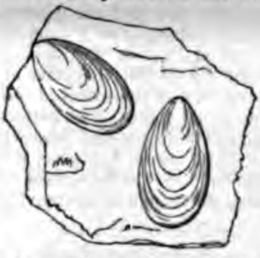
SIR,—Having within the last three weeks examined the Chesil Bank, I was much pleased to see by your November Number that the Rev. O. Fisher offers what I consider the true theory of that remarkable phenomenon, and one identical with the explanation noted down by me at the time.

The bank is undoubtedly the resultant of the mechanical action of the tides and prevailing winds, as modified by the leading features of coast configuration. Its regularity—appearing almost as an artificial embankment—is most striking, and points to a wonderful uniformity of action over a lengthened period of the producing causes. At Burton Cliff, its western extremity, it commences as a beach, gradually developing as it passes over the low lying land to the eastward into a bank or ridge with seaward and landward slopes, until it approaches the Coast Guard Station, where it again becomes a beach against a low cliff, cut by the sea into loose materials forming a projecting lip of land. At this point it is transversely cut through by deep gulleys, excavated by several little rills of water. Further on it again becomes a bank, and sweeps round in a majestic curve past Abbotsbury to Portland. Its independence of the minor configuration of the coast lying between Burton Cliff and Portland is very remarkable. The seaward slope, whether bank or beach, is in a continuous curve from its two extremes. The Fleet is only the natural consequence of the barriers built on the low lands.

Blundellsands, T. Mellard Reade, C.E.
November 17th, 1873.

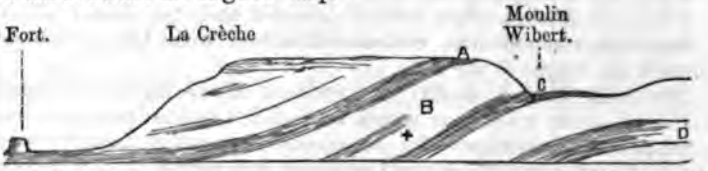
DISCOVERY OF *LINGULA OVALIS* IN THE KIMMERIDGE CLAY AT BOULOGNE-SUR-MER.

Sir,—Whilst on a short geological tour abroad early in September, I was fortunate enough to discover a *Lingula* in the Cliffs near Boulogne; and on my return home, I gave it to T. Davidson, Esq., F.R.S. He sent information of it to MM. Rigaux and de Loriol (who are publishing a work on the Boulogne fossils), and they both say it has never been discovered (or recorded) before, in the Kimmeridge Clay of Boulogne; though those cliffs have been searched for years, by French, English, and other geologists! The shell in question, *Lingula ovalis*, occurred in a block of shale, and was a beautiful specimen, quite perfect when I first found it, but it has got damaged since. Mr. Davidson has kindly drawn the following figure for me:



Lingula ovalis, Sow., Kimmeridge Clay, Boulogne-sur-mer.

I also give a rough sketch (from memory) of the place where I found it, for the benefit of geological visitors to Boulogne—the strata are named from M. Rigaux' map.



A. Grès à *Ammonites gigas.*
B. Schistes à *Thracia depressa.*
C. Grès à *Pygurus.*
D. Calcaire à *Arca longirostris.*
+ Place where I found the *Lingula*: in the Bay a few hundred yards south of La Crèche point.

It is not a little singular that within a fortnight after this discovery, I also found the same shell in the same formation in a core from the

Sub-Wealden boring, which I gave to Professor Phillips at Bradford, and which enabled him to report in *Nature* of Oct. 9th, that the boring was in Kimmeridge Clay.[1] This shell is characteristic of that formation at Shotover Hill, near Oxford, and at Ely, near Cambridge, and Mr. Davidson tells me that the Boulogne specimen is the same size as those from the above-named places, viz. about ¾ inch in length, and ½ inch in breadth, but the "sub-Wealden" *Lingula* is remarkable for being only about ⅛ inch in length.

I have since found two or three other specimens, and they are all of the same diminutive size: it may possibly be that they are young ones.

I hope soon to hear of some more good specimens turning up both from the boring and the Boulogne Cliffs.

St. Leonards, *Nov.* 3, 1873. John E. H. Peyton.

P.S.—Since writing the above, I have found the following additional fossils from the Sub-Wealden boring; depth about 300 feet:—a *Patella latissima*, an *Ostræa*, a *Pecten*, and a *Modiola*. They were shown to some of the Committee in Jermyn Street, and pronounced to be Kimmeridge Clay fossils; thus confirming Prof. Phillips's announcement in *Nature*, alluded to above.

Nov. 21. J. E. H. P.

OBITUARY.

Albany Hancock.—Zoologists have seldom had to mourn a greater loss than that which they have sustained by the death of Albany Hancock; and, as is so often the case when a scientific man of the first rank leaves this life, one subdivision of the sciences is not alone affected by it. Palæontology has also lost in Mr. Hancock an earnest and clear-sighted worker, and may be said to have reaped almost the last fruits of his labours. It is as a palæontologist that he must be commemorated here, and a glance at the accompanying list of his papers on ancient forms will show that the range of his knowledge as such gave him an indisputable right to the title.

Mr. Hancock was born in Newcastle in 1806, and died there on the 24th of last October. His life was, in the ordinary sense of the term, singularly uneventful. Scarcely ever did he leave his birthplace, which, with the dales and fells in its neighbourhood, he loved as north countrymen can, *never* did he forsake his pure naturalist's work. Each year of his manhood was marked by the discovery, accurate observation, and ever modest publication of new and important facts in Biology. His work speaks for itself; but the spirit in which he worked, his intense love of Nature for her own sake, his unaffected shrinking from honours which were forced upon him, his readiness to impart his knowledge or to give all help to the humblest beginner who was willing to work, his contempt of the so-called *popular* science of blatant sciolists, his life-long friendships, —all these must not pass away unrecorded. They cannot pass away unremembered by any one who knew him.

By Albany Hancock's death the small but strong circle of naturalists with whose names the early and brilliant days of the Tyneside Naturalists' Field Club will always be associated is once more thinned indeed.

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[1] See also letter from Prof. Phillips in Geol. Mag. for November, p. 527.

List of papers bearing on Palæontology and Geology by Albany Hancock:—

1. On the boring of the Mollusca into rocks, etc., and on the removal of portions of their shells.—Ann. Nat. Hist. ii., 1848, p. 225 (reprinted elsewhere).
2. Notice of the occurrence of Fossil Fish in the rocks (Marl-slate) near the great slip-dyke at Cullercoats Haven.—Tyneside Nat. F. C. Trans. i., 1848, p. 275.
3. On the excavating powers of certain Sponges belonging to the genus *Cliona*, with descriptions of several new species, etc.—Ann. Nat. Hist. iii., 1849, p. 321.
4. Remarks on certain vermiform Fossils found in the Mountain Limestone districts of the North of England.—Tyneside Nat. F. C. Trans. iv., 1858, p. 17.
5. On a peculiar reticulated appearance on the surface of a Clay Beach at Whitburn.—Tyneside Nat. F. C. Trans. iv., 1858–50, p. 69.
6. Notes on the excavating Sponges, with descriptions of new species.—Nat. Hist. Soc. Northumberland and Durham Trans. i., 1865–67, p. 337.

Papers by Albany Hancock and Thomas Atthey:—

7. Notes on various species of *Ctenodus* from the Shales of the Northumberland Coal-field.—Nat. Hist. Soc. Northumberland and Durham Trans. iii., p. 54.
8. On remains of Reptiles and Fishes from the Shales of the Northumberland Coal-field.—Nat. Hist. Soc. Northumberland and Durham Trans. iii., p. 66.
9. On a new Labyrinthodont Amphibian from the Northumberland Coal-field, and on the occurrence in the same locality of *Anthracosaurus Russelli.*—Nat. Hist. Soc. Northumberland and Durham Trans. iii., p. 310.
10. Note on *Anthracosaurus.*—Nat. Hist. Soc. Northumberland and Durham Trans. iii., p. 319.
11. On Fossil Fungi from the Black Shale of the Northumberland Coal-field.—Nat. Hist. Soc. Northumberland and Durham Trans. iii., p. 321.
12. On the generic identity of *Climaxodus* and *Janassa.*—Nat. Hist. Soc. Northumberland and Durham Trans. iii., p. 330.
13. On an undescribed Fossil Fish from the Newsham Coal Shale.—Nat. Hist. Soc. Northumberland and Durham Trans. iv., p. 199.
14. On the occurrence of *Loxomma Allmanni* in the Northumberland Coal-field.—Nat. Hist. Soc. Northumberland and Durham Trans. iv., p. 201.
15. Description of a Labyrinthodont Amphibian, a new generic form from the Coal Shale of Newsham.—Nat. Hist. Soc. Northumberland and Durham Trans. iv., p. 208.
16. Description of a mandibular Ramus of *Anthracosaurus Russelli*, with Notes on *Loxomma* and *Archichthys.*—Nat. Hist. Soc. Northumberland and Durham Trans. iv., p. 385.
17. Remarks on *Dipterus* and *Ctenodus*, and on their relationship to *Ceratodus Forsteri*, Krefft.—Nat. Hist. Soc. Northumberland and Durham Trans. iv., p. 397.
18. Descriptive Notes on *Pleurodus Rankinii*, on two new Species of *Platysomus* and a new *Amphicentrum*, with Remarks on a few other Fish-remains found in the Coal-measures at Newsham.—Nat. Hist. Soc. Northumberland and Durham Trans. iv., p. 408.

Papers by Albany Hancock and Richard Howse:—

19. On a new Labyrinthodont Amphibian from the Magnesian Limestone of Midderidge, Durham.—Quart. Journ. Geol. Soc., vol. 26, 1870, p. 556.
20. On *Dorypterus Hoffmanni*, Germar, from the Marl-slate of Midderidge, Durham.—Quart. Journ. Geol. Soc., vol. 26, p. 565.
21. On *Janassa bituminosa*, Schlot., from the Marl-slate of Midderidge, Durham.—Nat. Hist. Soc. Northumberland and Durham Trans. iii., p. 339.
22. On *Proterosaurus Speneri*, v. Meyer, and a new species, *Proterosaurus Huxleyi*, from the Marl-slate of Midderidge, Durham.—Nat. Hist. Soc. Northumberland and Durham Trans. iv., p. 232.

G. A. L.

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